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DREAMS.

BY EDWARD CLODD.

THE remarks which follow some questions concerning the attitude of science towards dreams, asked in KNOWLEDGE of Nov. 25,* indicate how belief in their quasi-supernatural character lurks in the minds of intelligent persons who would resent being called superstitious.

Certainly, the antiquity and persistence of that belief are small matter of wonder when we reflect that the phenomena of dreaming are precisely of a character to sustain that feeling of mystery which man's surroundings awaken within him; but an inquiry into its origin and growth may best dispel it, while such an inquiry will add its witness to that of the "great cloud of witnesses" concerning the survival, often in least suspected form, of rude primitive philosophies among the elaborated beliefs of civilised races.

The youngest and most vigorous of the sciences, Anthropology, has already made us familiar with the nature of a vast body of evidence, uniform in character, unearthed from old river-valleys, caverns, mounds, and tombs, witnessing to the primitive savagery of man and his slow uprising therefrom; but such evidence touches us only on the intellectual side. Even should desired skeletons of veritable men of miocene times—still better, of the "missing" *homo simius*—turn up, we should yet be within the limits of palæontology and zoology. Such relics of our remote ancestry would remain specimens only—"a little less than kin." It is not until the evidence from the Drift and from surface remains (about which KNOWLEDGE may hereafter tell its readers more in detail) gives place to that supplied by immaterial relics—articulate speech, myths which were for the time real, and sufficing explanations to him—that man touches us as *fellow*-man, as *thinker*,† striving to read "the riddle of the painful earth," and to peer into the mysteries of being.

Now, for the purpose of this inquiry, it is needful to have understanding of the mental condition of races in low stages of culture, and, generally, it may be said that the modern savage is, as the primitive savage was, in a state of "fog" concerning the nature and relation of what is in the mind to what is outside it. In this he may perchance command the sympathy of the modern philosopher, there being this important difference between the two, that while the philosopher speculates upon the nature of the connection between his mind and the external world, and confesses that "his knowledge of matter is restricted to those feelings of which he assumes it to be the cause," the savage has no capacity for such thought at all. He has nothing in his slender stock of words corresponding to the terms "objective" and "subjective;" that stock has no substantive verb "to be"—as, indeed, few of the languages of the world have ever had. He cannot distinguish between an idea and an object, an illusion and a reality, a substance and its image or shadow; and under bodily ailment, indigestion born of gorging, or delirium caused by starving, gives shape and substance, a "local habitation and a name," to "airy nothings," spectres of diseased or morbid imagination. Misled by superficial resemblances, he jumps at the most absurd conclusions; ignorant of the necessary relation between cause and effect, he is "carried about with every wind of" fancy; nor has he the capacity, which is the measure of intellectual growth, to strip the special of its accidents, and sink it in the general.

For example, he gives a different name to the tails of various animals, but has no name for "tail" in general; he can speak of sunshine, candle, fire-flame, etc., but "light" is an abstract term which he is unable to grasp. Such is his confusion between a thing and its symbol, that the name of a man is held to be an integral part of himself; he shrinks from revealing his own, lest the man to whom he imparts it injures him through it; still more does he recoil from naming the dead, or powers credited with baleful influence. He dreads having his portrait taken, feeling that some part of himself has gone in the process; the better the likeness, the more has "virtue gone out of him." Catlin relates that he caused great commotion among the Sioux by drawing one of their chiefs in profile. "Why was half his face left out?" they asked; "Mahtoochega was never ashamed to look a white man in the face." The chief himself did not take offence, but Shonka, the Dog, taunted him, saying, "The Englishman knows that you are but half a man; he has painted but one-half of your face, and knows that the rest is good for nothing." Which led to a quarrel, and in the end Mahtoochega was shot, the bullet tearing away just that part of the face which Catlin had not drawn.

We may now more clearly understand how the savage will interpret phenomena of a more complex order, and why he can interpret these only in one way. The phantasies which have flitted across the brain in coherent order or unrelated succession when complete sleep was lacking, leave the traces of their passage on the memory, and they are strong of head and heart, "true peptics who have no system," as Carlyle says, whose awakened consciousness is not affected by the harmonious or discordant, the painful or pleasant, illusions which have composed their dreams. But while for us they fill an empty moment in the telling, albeit now and again causing "eerie" feelings, and quickening such remains of superstition as slumber in the majority of us, they are to the untrained intelligence of the savage as solid as the experiences of his waking moments, true not only "while they last," but for ever afterwards. And the limits of his language only deepen the confusion within him when he tells what he has seen, and heard, and felt, and

* "Query 24," p. 80.

† "Man, a derivative root, means to think. From this we have the Sanskrit manu, originally thinker, then man."—Max Müller's *Lect. Lang.* I., 437.

whither he has been. For the speech cannot transcend the thought, and, therefore, can represent neither to himself nor to his hearers the difference between the illusions of the night and the realities of the day. The dead relations and friends who appear in dreams and live their old life; with whom he joins in the battle or the chase; with whom, the toils over, he sits down to feast, not, like the Psalmist, in the presence of his enemies, but upon succulent slices of the enemies themselves; the foes with whom he struggles, the wild beasts from which he flees, or in whose grip he feels himself, and, shrieking, awakens his squaw; the long distances he travels to dreamlands beyond and above—are all real, and no "baseless fabric of a vision." The belief is strengthened by that intensified form of dreaming called "nightmare,"* when gaping, grinning, spectre-monsters sit upon the breast, stopping breath and paralysing motion, which has helped to create the vast army of nocturnal demons that fill the folk-lore of the world, and that under infinite variety of hideousness have had lodgment for centuries in the beliefs of higher races.

What Schoolcraft says of the Indian mind, that "a dream or a fact is alike patent to it," applies throughout the whole range of the lower culture, a marked and widespread form of the confusion being in the belief that the soul leaves the body during sleep. Among the Zulus, when dead relatives appear to a man in his sleep, he concludes that their spirits still live, and the savage notion, that a sleeper should not be wakened, because of the possible absence of his soul, finds some continuity in the belief of mediæval times, that trance and catalepsy were proofs of the temporary departure of the soul from the body. Hence, as Mr. Fiske has remarked, "it was no easy matter for a person accused of witchcraft to prove an *alibi*; for to any amount of evidence showing that the body was innocently reposing at home and in bed, the answer was obvious, that the soul may, nevertheless, have been in attendance at the witches' Sabbath, or busied in maiming a neighbour's cattle!"

(To be continued.)

INTELLIGENCE IN ANIMALS.

WIGAN, in his "Duality of the Mind," says that he once offered an apple to an elephant, letting the apple drop at the moment the elephant was about to seize it, so that it rolled out of its reach. The elephant waited a moment to see if Wigan would pick it up, and being disappointed in this expectation, set himself to blow violently against the opposite wall, and the recoil forced the apple to his feet. This may be regarded as a case of practical, rather than of abstract reasoning. Yet, as Wigan remarks, it was a trick which no one could have taught the animal, and "it must have arisen from a process of reflection perfectly similar to that which takes place in the human mind" under similar conditions. We have, indeed, he justly remarks, "examples of human minds not even capable of the degree of thought possessed in this instance by the elephant, yet performing, by a sort of automacy (*sic*) all the ordinary functions necessary to their occupation. In some of the mechanical processes in our great manufactories, where the minute subdivision of labour reduces the art of each individual almost to the very ultimate elements of muscular motion, I think that I have seen individuals incapable of a similar process."

In the following instance, from the same work, we have ingenuity combined with, and suggested by, indignation: "A large grey spider established himself in a recess formed by a shed and a projection of the house, and taking his long line diagonally from the corner of the house to the eaves of a small building which was at the bottom of the recess, he then filled up the triangular space with a well-defined circular web. I had noticed with admiration during the day his wonderful skill, the accuracy of his lines, and the equality of the spaces, and observed how carefully he pushed down his line, and fastened it securely with his two hind feet to each radius in succession. When he had finished about two-thirds of his concentric circles, or rather of his helix, he went to the centre and swallowed a quantity of white tenacious mucus, which he had deposited there at the commencement, having apparently spun himself out; he then proceeded to complete his work, which having accomplished, and thus reduced himself to very small dimensions, he hung himself up by the hind legs, and I presume went to sleep. The slightest touch of a fly was, however, sufficient to make him start out, and having wrapped up a few of them in his toils and well stocked his larder, he again betook himself to repose. In the meantime, one of the smaller spiders, considering that the diagonal line of his neighbour was strong enough to bear two webs, began to attach his lines to it, and having so done in four or five places, proceeded to spin his own web. My older friend tolerated the intrusion very patiently, and acquiesced in the use his neighbour was making of the "party wall," though against *spider law*. By-and-by the newcomer, having partly fitted up his own trap, and finding that no flies came into it, observing, I presume, the ample supply of food in his neighbour's premises, advanced along one of his own lines, seemingly for the purpose of open burglary. My old friend had tolerated much, but this was a degree of impudence for which he was not prepared, and which he determined to punish forthwith. He proceeded to the centre of his web, and giving the whole framework a violent shake, hoped to shake the intruder down upon the ground. He did no more, however, than turn him round on the line, where he hung very patiently till the shaking ceased, and then resumed his march towards his neighbour's territory. Again and again, and with increasing violence, did the large spider shake his web—it was all in vain; there was the enemy advancing, and though so small as to be easily overpowered, should he reach the mainland, the insult of the attempt was intolerable. On looking round, my elder friend saw that, during the violent shakes, he had broken two or three of his own short lines, and he left his opponent and set himself to work to mend them. Having completed the task to his perfect satisfaction, he returned to the burglar. The latter, when he came near, saw at once that he had been rash in provoking such an enemy, and hurried back to his own web. When his opponent saw him on his thin line in his retreat, he again set himself to his shaking fit, and made the most violent efforts to throw him down; it was all in vain, however, and he got safe home. After a moment's consideration, the other seemed to think that so audacious an attempt ought to be condignly punished, and he determined to retort the invasion. The thin lines of his diminutive antagonist, however, did not afford a sufficient support for his heavy bulk, and as he advanced, he carefully spun a strengthener upon the other's tenuous cord. It was now the little one's turn to shake off the intruder, and twice did he break the thin part of the line, and leave his enemy dangling. At last, the latter gave up the attempt, and went back to the centre of his own web, *after carefully detaching every one of the lines* which his neighbour had had the impudence to fasten to his long diagonal."

* *i.e.* Night-spirit. A.S. märe, nymph.

In this case we seem to recognise on both sides reasoning which approaches at times the abstract. In the calculation of means to an end, and change of plan in consequence of unexpected obstacles, there is practical reasoning. As Wigan well says, "Had the human race spun webs, and dared one another to single combat, they could not well have shown more judgment and skill in the attack and defence. The strengthening of the lines to bear the shaking, and doubling the smaller spider's lines while using them as lines of advance, belonged also to the order of practical reasoning, though of a rather advanced kind. But there was abstract reasoning, it seems to us, or a near approach to it, in the conduct of the smaller spider, first of all, in considering, as it were, how far he might trespass on the patience of an enemy whom he recognised as his superior, and again in the conduct of the larger in deciding when the time had come to give his small enemy a lesson, and in retreating finally without persisting, as if reflecting that his purpose was as well achieved as though he had actually driven the smaller spider from his web. His removing the lines which had supported the smaller web, though he had previously allowed them to remain, looks very much like a result of abstract reasoning.

We find illustrated by such instances the remark of Dr. Prichard, that among insects, if we take the different tribes collectively, manifestations of all the psychical qualities which we observe in mammifers and birds (regarding as a whole the properties divided among different departments), may be recognised in the most strict analogy. Attention, memory, the faculty of combining means to attain ends, cunning, the desire of revenge, care of offspring, and all the other psychical qualities which have been traced in the former class of animals (mammifers) are likewise to be observed in the latter as typical or characteristic phenomena—sometimes in one combination, sometimes in another; or, in different groups, sometimes strongly, sometimes more feebly expressed.

SOLIDS, LIQUIDS, AND GASES.

By W. Mattieu Williams.

PART IV.

As already explained, all gases are now proved to be analogous to steam; they are matter expanded and rendered self-repulsive by heat. All *elementary* matter may exist in either the three forms—solid, liquid, or gas, according to the amount of heat and pressure to which it is subjected. I limit this wide generalisation to *elementary* substances for the following reasons.

Many compounds are made up of elements so feebly held together that they become "dissociated" when heated to a temperature below their boiling-point. Or their condition may be otherwise defined by stating that the bonds of chemical energy, which hold their elements together, are weaker than the cohesion which binds and holds them in the condition of solid or liquid, and are more easily broken by the expansive energy of heat. To illustrate this, let us take two common and well-known oils, olive oil and turpentine. The first belongs to the class of "fixed oils," the second to the "volatile oils." If we apply heat to liquid turpentine, it boils, passes into the state of gaseous turpentine, which is easily condensible by cooling it. If the liquid result of this condensation is examined, we find it to be turpentine as before. Not so with the olive oil. Just as this reaches its boiling point, the heat, which would otherwise convert it into olive-oil vapour, begins to dissociate its constituents, and if the temperature be raised a little higher, we obtain some gases, but these are the products of decomposition, not gaseous olive oil. This is called "destructive" distillation.

In olive oil, the boiling-point and dissociation point are near to each other. In the case of glycerine, these points so nearly approximate that, although we cannot distil it unbroken under ordinary atmospheric pressure, we may do so if some of this pressure is removed. Under such diminished pressure, the boiling-point is brought down below the dissociation point, and condensible glycerine gas comes over without decomposition.

Sugar affords a very interesting example of dissociation, commencing far below the boiling point, and going on gradually and visibly, with increasing rapidity as the temperature is raised. Put some white sugar into a spoon, and heat the spoon gradually over a smokeless gas-flame or spirit-lamp. At first the sugar melts, then becomes yellow (barley sugar); this colour deepens to orange, then red, then chestnut-brown, then dark brown, then nearly black (caramel), then quite black, and finally it becomes a mere cinder. Sugar is composed of carbon and water; the heat dissociates this compound, separates the water, which passes off as vapour, and leaves the carbon behind. The gradual deepening of the colour indicates the gradual carbonisation, which is completed when only the dry insoluble cinder remains. An appearance of boiling is seen, but this is the boiling of the dissociated water, not of the sugar.

The dissociation temperature of water is far above its boiling-point. It is 5,072° Fah., under conditions corresponding to those which make its boiling-point 212°. If we examine the variations of the boiling-point of water, as the atmospheric pressure on its surface varies, some curious results follow. To do this the reader must endure some figures. They are extremely simple, and perfectly intelligible, but demand just a little attention. Below are three columns of figures. The first represents atmospheres of pressure—*i.e.*, taking our atmospheric pressure when it supports 30 inches of mercury in the barometer tube as a unit, that pressure is doubled, trebled, &c., up to twenty times in the first column. The second column states the temperature at which water boils when under the different pressures thus indicated. The third column, which is the subject for special study just now, shows how much we must raise the temperature of the water in order to make it boil as we go on adding atmospheres of pressure, or the increase of temperature due to each increase of one atmosphere of pressure. The figures are founded on the experiments of Regnault.

Pressure in Atmosphere.	Temperature F. °	Rise of Temperature for each additional Atmosphere.
1	212	37·5
2	249·5	23·8
3	273·3	17·9
4	291·2	14·8
5	306·0	12·2
6	318·2	11·4
7	329·6	9·9
8	339·5	8·9
9	348·4	8·2
10	356·6	7·6
11	364·2	6·9
12	371·1	6·7
13	377·8	6·2
14	384·0	6·0
15	390·0	5·4
16	395·4	5·4
17	400·8	5·1
18	405·9	4·9
19	410·8	4·6
20	415·4	—

It may be seen from the above that, with the exception of one irregularity, there is a continual diminution of the

additional temperature which is required to overcome an additional atmosphere of pressure, and if this goes on as the pressure and temperatures advance, we may ultimately reach a curious condition—a temperature at which additional pressure will demand no additional temperature to maintain the gaseous state; or, in other words, a temperature may be reached at which no amount of pressure can condense steam into water, or where the gaseous and liquid states merge or become indifferent.

But we must not push this mere numerical reasoning too far, seeing that it is quite possible to be continually approaching a given point, without ever reaching it, as when we go on continually halving the remaining distance. The figures in the above do not appear to follow according to such a law—nor, indeed, any other regularity. This probably arises from experimental error, as there are discrepancies in the results of different investigators. They all agree, however, in the broad fact of the gradation above stated. Dulong and Arago, who directed the experiments of the French Government Commission for investigating this subject, state the pressure at 20 atmospheres to be 418·4 at 21=422·9, at 23=427·3, at 23=431·4, and at 24 atmospheres, their highest *experimental*, limit 435·5, thus reducing the rise of temperature between the 23rd and 24th atmosphere to 4·1.

If we could go on heating water in a transparent vessel until this difference became a vanishing quantity, we should probably recognise a visible physical change coincident with this cessation of condensibility by pressure; but this is not possible, as glass would become red-hot and softened, and thus incapable of bearing the great pressure demanded. Besides this, glass is soluble in water at these high temperatures.

If, however, we can find some liquid with a lower boiling-point, we may go on piling atmosphere upon atmosphere of elastic expansive pressure, as the temperature is raised, without reaching an unmanageable degree of heat. Liquid carbonic acid, which, under a single atmosphere of pressure, boils at 112° below the zero of our thermometer, may thus be raised to a temperature having the same relation to its boiling-point that a red heat has to that of water, and may be still confined within a glass vessel, provided the walls of the vessel are sufficiently thick to bear the strain of the elastic outstriving pressure. In spite of its brittleness, glass is capable of bearing an enormous strain *steadily applied*, as may be proved by trying to break even a mere thread of glass by direct pull.

Dr. Andrews thus treated carbonic acid, and the experiment, as I have witnessed its repetition, is very curious. A liquid occupies the lower part of a very strong glass tube, which appears empty above. But this apparent void is occupied by invisible carbonic acid gas, evolved by the previous boiling of the liquid carbonic acid below. We start at a low temperature—say 40° Fahr. Then the temperature is raised; the liquid boils until it has given off sufficient gas or vapour to exert the full expansive pressure or tension due to that temperature. This pressure stops the boiling, and again the surface of the liquid is becalmed. This is continued until we approach nearly to 88° Fahr., when the surface of the liquid loses some of its sharp outline. Then 88° is reached, and the boundary between liquid and gas vanishes; liquid and gas have blended into one mysterious intermediate fluid; an indefinite fluctuating something is there filling the whole of the tube—an etherealised liquid or a visible gas. Hold a red-hot poker between your eye and the light; you will see an upflowing wavy movement of what appears like liquid air. The appearance of the hybrid fluid in the tube resembles this, but is sensibly denser, and evidently stands between the liquid and gaseous states of matter, as pitch or treacle stands between solid and liquid.

The temperature at which this occurs has been named by Dr. Andrews the "*critical temperature*;" here the gaseous and liquid states are "*continuous*," and it is probable that all other substances capable of existing in both states have their own particular critical temperatures.

Having thus stated the facts in popular outline, I shall conclude the subject in my next paper by indulging in some speculations of my own on the philosophy of these general facts or natural laws, and on some of their possible consequences.

PERSPECTIVE ILLUSIONS.

By H. J. Slack, F.G.S., &c.

SOME persons have very little perception of perspective, and whole nations, as the Chinese, whether or not impressed by its effects, are not offended by drawings made in defiance of its rules. If experiments are made with English folk of different ages and degrees of education, a large proportion will be found obtuse in perceiving, and inaccurate in observing, the optical aspects of buildings, pieces of furniture, crockery, &c., as seen from different positions. On the other hand, the more artistically-cultivated or more naturally-endowed persons are extremely sensitive to all such effects; and, in some cases, most easily deceived. Etchings in simple lines, without shading, such as Flaxman's illustrations of Dante, show how easily the eye is led, by slight thickenings, curves, and angular approximations, to conceptions of distance or superposition, and it is probable that the illusions thus produced are strongest in the sharpest observers. Persons are sometimes met with who see nothing of the kind, and to whom all drawings look flat. Illusion figures are most deceptive when they give no hint of the real facts. Thus, your Fig. 8, p. 70, deceives an observer who finds no illusion in Fig. 9 on the opposite page. I see the illusions in both, but strongest in Fig. 8. Fig. 9 is more like a mosaic pavement, in regard to which the knowledge that the surface is flat makes it seem so, in spite of the lines. In looking at pictures and engravings, the mind willingly accepts their perspective indications. In Fig. 8 the illusion is produced by the series of diminishing arcs from the edge of the outer circle inwards. These correspond sufficiently with the representation in perspective of a series of curved objects of the same size, but looking smaller and smaller as the distance increases. This makes the centre of the line AB appear to bend inwards.

Compound vibration curves described in fine lines on paper are very deceptive. Mr. Washington Teasdale, who has great skill in these matters, has supplied me with many beautiful illustrations of this fact. He has also enabled me to make a variety of experiments with similar patterns, minutely ruled on glass as microscopic objects. The optical illusions are strongest when the lines correspond with those used in perspective drawing; and high magnification (say 1,000 ×) does not dissipate the impression, if enough of the pattern remains visible in the diminished field. When bands of lines of the same thickness cross each other, it is extremely difficult to illustrate them so as to make them look on one plane. Of two such series, either may be made to look uppermost. With large angle of operation and high powers, I believe it is quite impossible to obtain certain information of the structure of many objects, unless there are good reasons, independent of vision, for supposing one optical appearance more correspondent with fact than another.

Mr. Teasdale obliged me with a number of the compound vibration and curve slides, done in testing his apparatus, more or less imperfect. These are highly instructive. One especially, a spiral, with the initial part roughly scratched, and the subsequent parts wholly clear and fine, appears as a deep hollow under the microscope with minocular vision. A well known physiologist and microscopist, to whom it was shown, saw this perspective effect strongly when using one eye, but lost the illusion the moment both eyes were employed with the prism. This observer has both eyes better matched than usual, and trials with various persons show that the illusion is only partially dissipated when the binocular apparatus is used by persons whose eyes differ in focus, as is very common.

Reviews.

BRITISH FERNS.*

MANY find the study of ferns a difficult task, on account of the difficulty of recognising the distinguishing characteristics of each genus or class. The book before us is intended to remove this obstacle. At the beginning, a careful explanation is given of the general divisions of flowerless plants; of the different parts of ferns; of terms applicable to the shapes, etc., of their fronds; the grouping of ferns; and the genera of British ferns. Tables are given of each species separately, and according to the following plan, the technical terms used in which will be found fully explained in Miss Ridley's work.

1. First the scientific title is given, with the abridged or full name of the botanist who first gave this name, and after that the common name by which the fern is known.
2. In each instance the special points of the genus are indicated under the heading of generic characters.
3. Under distinctive specific characters are noted the special peculiarities and the points of difference by which the fern is known from all others of the genus to which it belongs.
4. Whether the fern has a rhizome or caudex.
5. The characters of the stipes and rachis.
6. The scales of the stipes.
7. The shape of the frond; its average size, the length and width being ascertained.
8. The texture of the frond, some ferns being hard and leathery, others very soft, thin, and transparent.
9. Whether deciduous (that is, shedding its fronds in autumn) or not.
10. The arrangement of the veins in the fronds.
11. Position of the receptacle.
12. Sori, shape of, and usual quantity.
13. Whether the sori are dorsal or marginal.
14. If there is an indusium or involucre, or neither; when present, shape and character of such.
15. Locality, or where found.
16. Lastly come the general remarks to each species.

At the end of the book is an index containing a list of technical terms used in the book, by which easy reference can be made to the page on which the meaning has been given. With such a help as this little pocket guide, many difficulties will be removed, and the study of ferns will be made both easy and interesting.

HIEROGLYPHIC INSCRIPTIONS OF THE SAKARA PYRAMIDS.

By a Member of the Society of Biblical Archæology.

THE recent magnificent discovery of royal mummies, papyri, and numerous other relics at Egyptian Thebes has been so surprising, as to throw unduly into the shade the almost equally important results attending the opening of pyramids at Sakara earlier in the year; doubly interesting, because their chambers and passages, contrary to those of pyramids previously explored, were found, except where mutilated, to be covered with hieroglyphics The literature thus so marvellously preserved was soon seen to be of a very similar character to the most archaic chapters of the "Ritual," or "Book of the Dead," and of great mythological and theological value. They are, however, owing to their extreme antiquity, notwithstanding the distinctness and delicacy of the carved and painted pictorial hieroglyphics (which are equal to that of almost any other epoch), very difficult to translate, because many signs and ideas are used, or expressed differently from those of more recent texts with which scholars have hitherto chiefly been acquainted. Some of the inscriptions have now been published by Lepsius, in his "Egyptian Review," and a tentative translation of a portion of them made by Bruscgh Bey.

The most valuable fact brought to light by a careful study of this decipherment of the texts is the decisive manner in which it enforces an immediate reconsideration of what were previously considered as axioms in Egyptology. Most, if not all, the myths and legends supposed to have been engrafted into the Egyptian religion at long subsequent dates are here found to be fully rife; not so much because some either appear in part or even amplified in the texts themselves, especially the Myth of Nut, but on account of the numerous allusions to, and short quotations from, legends which, to the initiated, at once called up, by a long train of associations, the story thus frequently only indicated by a sort of *double entendre*.

The whole history of Osiris, with his consequent belief in one supreme ever-existent deity, and account of a future judgment, with subsequent states of reward or punishment, is in full sway. It is distinctly and emphatically asserted of one deceased King, Pepi, that he is not really dead or annihilated, but that he has "received his spirit," or become spiritualised in the abode of the blessed. The legend of the struggle and triumph of Horus over Set, or of good over evil, is seen fully developed, as are many others. Ra, Sele, Harmachis, Tum, Tefunt, Harpocrates, Buto—in fact, nearly all the pantheon, hitherto considered to be a gradual accumulation of centuries after by many authorities—here burst into view in full splendour, and especially even Amen has his place.

The dog-star Sirius is mentioned in respect to its chronological importance, proving a careful observance of the constellations for at least two periods of fourteen and a half centuries previous to the writing of the inscriptions, or perhaps still older copies from which they were taken, and the objects depicted in the hieroglyphs indicate fully as advanced a culture and high civilisation as that of any epoch prior to the shepherd kings. The Elysian fields of heaven, besides many other places and events described in the ritual of the dead, are prominent, showing that this Bible of Egypt had long before been compiled and reverenced.

From this short *résumé* it will be gathered that these pre-eminently ancient texts afford no ground for arguments based on a theory of gradual development of Egyptian religion, from gross fetichism or anthropomorphic ideas; on the contrary, the theology exemplified is more spiritual, and diverges less into pantheism and animal worship by far than that of subsequent times. What are now believed to be divine truths, whether evolved out of necessity from man's spiritual nature, or imparted by primæval revelation, are, in fact, less buried beneath a *débris* of idolatry and ignorant superstition, than in the era when Egyptian religion (because misunderstood) became a jest to the writers of Greece and Rome.

A fortunate result of these explorations is also to terminate for ever the apparently endless controversy as to the original purport of the pyramids. These newly-opened pyramids are certainly the mausoleums of the monarchs whose names, creeds, and coffins they contain, and there can be no doubt but that such was the Great Pyramid which formed the basis for the wonderful conjectures of Prof. Piazzi Smyth and his school.*

These discoveries are almost certainly but the commencement of others equally interesting, for there are in the Nile Valley quite a number of pyramids yet unopened, and it is M. Maspero's announced intention to inaugurate his accession to the post of Marriette Pasha by completely exploring every one that is known.

* "A Pocket Guide to British Ferns," by Marian S. Ridley. (London: D. Bogue.)

[* I do not accept the wonderful conjectures of the Astronomer-Royal for Scotland; but no astronomer can doubt the astronomical significance of the structural details of the Great Pyramid. Whether intended as a tomb or not, it was certainly erected by men exceedingly well skilled in astronomy and mathematics, and as certainly astronomical observations, of considerable difficulty and requiring great exactitude, were carried on during its erection. Whether the Great Pyramid was erected with so much precision in order that astronomical observations might be made from it with great exactitude, or whether astronomical observations were made from it with great exactitude in order that it might be erected with great precision, may be a moot point. I have scarcely any doubt myself that both purposes were in view, the former as the primary one. —Ed.]

Letters to the Editor.

[The Editor does not hold himself responsible for the opinions of his correspondents. He cannot undertake to return manuscripts or to correspond with their writers. He requests that all communications should be as short as possible, consistently with full and clear statements of the writer's meaning.]

All Editorial communications should be addressed to the Editor of KNOWLEDGE*; all Business communications to the Publishers, at the Office, 74, Great Queen-street, W.C.*

All Remittances, Cheques, and Post-Office Orders should be made payable to Messrs. Wyman & Sons.

**** All letters to the Editor will be Numbered. For convenience of reference, correspondents, when referring to any letter, will oblige by mentioning its number and the page on which it appears.*

All Letters or Queries to the Editor which require attention in the current issue of KNOWLEDGE*, should reach the Publishing Office not later than the Saturday preceding the day of publication.*

"In knowledge, that man only is to be contemned and despised who is not in a state of transition. . . . . Nor is there anything more adverse to accuracy than fixity of opinion."—*Faraday.*

"There is no harm in making a mistake, but great harm in making none. Show me a man who makes no mistakes, and I will show you a man who has done nothing."—*Liebig.*

Our Correspondence Columns.

TO OUR READERS.

[82]—Last week we had to add two leaves, including three pages of matter, to what we had intended to be our full weekly supply for at least the first half-year, and, probably, for the first year of our issue, and yet no less than 14 pp. of matter remained over. Our readers will see, therefore, that we lie under a considerable difficulty. We wish to find room for the better part of all the correspondence which reaches us. But we cannot do so without condensing most of the letters; and even so, we run over the limits which prudence dictates to us as suitable for a journal at the low price we have adopted. On the other hand, we have much to encourage us, even in the very circumstance which occasions our difficulty. Before we reached our fifth number we were receiving more correspondence than we expected to receive after we had been a year before the public; and the amount of this correspondence really measures the kindness of the welcome extended to us. That the friends we have already made are finding for us a welcome elsewhere, we know by the rate at which our circulation grows. We have had to reprint both our first and second numbers (every line having to be recomposed); and the indications are, that large though the second edition of No. 1 was, a third will before long be required. All this is very gratifying, and it leads us to hope that, long before we had expected, we shall be able to enlarge our weekly number. It may, perhaps, be said, that there are journals larger than ours at the same price, and that therefore we might at once enlarge our issue. There may be such journals, but if there is one giving anything like the same amount of original matter on *scientific* subjects at the same price, we have yet to hear of it. With the size we already have, and the amount of original (and costly) matter we give our readers, a very large sale is required to enable us permanently to enlarge each number. We shall not wait till such a sale is attained, but shall increase our weekly number in anticipation—probably long before. But our readers will understand that their co-operation is still needed. In the first place, each reader who contributes to our correspondence columns is earnestly requested to limit his remarks to subjects suitable to KNOWLEDGE, and to condense them to the utmost of his power. Then, each who approves our purpose can greatly help by making us known to others, noting to them in turn that they also, if content with us, can help to extend our sphere. We may point to the last four weeks' issue in evidence that we are anxious to meet our readers' wants by enlarging our numbers—without, however, engaging that such enlargement shall be permanent yet awhile. We may, indeed, note this, that if we had so kept down our correspondence and original matter as not to exceed what was given in our first number, our present issue, though the growth of only five weeks, would be remunerative. We have preferred, however, to increase our number, even at the risk of loss, and we shall continue to follow that policy so long as we receive such encouragement as heretofore from our readers and correspondents.

THE EDITOR AND PROPRIETORS OF "KNOWLEDGE."

"J. P. S." suggests that we should do as other papers dealing with popular science have done, in having reports of the meetings of scientific societies. We would gladly,—if we could afford the space to do it properly. But let our friendly adviser consider how the matter stands. We already find it difficult to find space for what is absolutely essential as regards the purpose set before us. Now, the reports of scientific societies in the *Athenæum* for Nov. 26, which devotes only a section to science, and therefore condenses such reports as much as possible, occupy a page and a third, which, in the larger type of our correspondence columns, would be about a page and three-quarters. Now, let us ask how the readers for whom we specially cater, would care for so much space being occupied with reports like those in the *Athenæum*, excellent as those reports are in their proper place there. For instance, under the head "Chemical Society," we find this. "The following papers were read:—'Aluminium Alcohols, Part II. Their Products of Decomposition by Heat,' by Messrs. J. H. Gladstone and A. Tribe,—'On the Chemical Action of Decomposing Vegetable Matter on the Rock-forming Sediment of the Carboniferous Period,' by Mr. E. Wethered,—'On α and β Amylam,' by Mr. C. O'Sullivan,—'On the Action of Oxides on Salts, Part IV. Potassic Chlorate and Ferric Oxide,' by Messrs. E. J. Mills and G. Donald,—and 'On the Steeping of Barley,' by Messrs. E. J. Mills and J. Pettigrew."

Or take the following report of the Royal Society (Mr. W. Spottiswoode, President, in the chair):—"The following papers were read: 'Preliminary Note on the Photographic Spectrum of Comet *b*, 1881,' by Mr. W. Huggins,—'Note on the Reversal of the Spectrum of Cyanogan,' by Profs. Liveing and Dewar,—'The Sum of the Series of the Reciprocals of the Prime Numbers and of their Powers,' by Mr. C. W. Merrifield,—'Further Note on the Minute Anatomy of the Thymus,' by Mr. H. Watney,—'On the Production of Transient Electric Currents in Iron and Steel Conductors,' by Prof. Ewing,—'Experimental Researches on the Propagation of Heat by Conduction in Bone, Brain-tissue, and Skin,' by Dr. Lombard,—'On Allotropic or Active Nitrogen, and on the Complete Synthesis of Ammonia,' by Mr. G. S. Johnson,—'On the Comparative Structure of the Brain in Rodents,' by Mr. W. B. Lewis,—'The Prehensores of Male Butterflies of the Genera Papilio and Ornithoptera,' by Mr. P. H. Gosse,—'On the Propagation of Inhibitory Excitations in the Medulla Oblongata,' by Dr. H. Kronecker and Mr. S. Meltzer,—'Researches on Chemical Equivalence,' Parts IV. and V., by Mr. E. J. Mills,—and 'On the Refraction of Plane Polarised Light at the Surface of a Uniaxal Crystal,' by Mr. R. T. Glazebrook."

Or let us turn to a paper more especially devoted to science—*Nature*. Here the reports, as might be expected, are fuller; but they would scarcely correspond with our special purposes. Here is the report of the Entomological Society:—

H. T. Stainton, F.R.S., President, in the chair.—Exhibitions: An aberration of *Urapteryx sambucaria*, L., Mr. C. O. Waterhouse.—A new species of *Antheræa* from the Gold Coast; and some microscopic preparations of the saws, &c., of various *Hymenoptera*, prepared by Mr. P. Cameron of Glasgow, Mr. W. F. Kirby.—Pieces of honeycomb constructed on a bare wall, without any protection; and specimens and figures of new varities of *Armadillium vulgare*, L., and *Porcellio icaber*, Latr. Rev. A. E. Eaton.—A specimen of *Lycæna icarus*, Rott., var. *Icarinus*, Scriba, Dr. H. G. Lang.—An undescribed species of *Cicadidæ* from Borneo, with unusually developed opercula, Mr. W. L. Distant.—A female specimen of *Dufourea Minuta*, Lep., Mr. T. R. Billups.—A specimen of *Scleroderma domestica*, Westw.; the larva was found parasitic on that of a Longicorn beetle in a pine-tree at Lyons; and some *Diptera* which attack figs in Turkey and Egypt, Sir S. S. Saunders (this led to an interesting discussion on fig-parasites and caprification).—Some remarkable tubes formed by Lepidopterous larvæ at Aden; and a specimen of *Cerura vinula*, L., which it was thought at first might belong to *C. erminea*, Esp., the President.—Papers read: Descriptions of new genera and species of Heterocerous *Lepidoptera* from Japan (concluded), by Mr. A. G. Butler; and a memoir on the various Dipterous insects (*Muscidæ* and *Tipulidæ*) destructive to cereals in Britain, by Professor Westwood."

The report of the Geological Society runs thus:—"R. Etheridge, F.R.S., President, in the chair. The following communications were read:—'On the genus *Stoliczkaria*, Dunc., and its distinctness from *Parkeria*, Carp. and Brady,' by Prof. P. Martin Duncan, M.B. Lond., F.R.S., F.G.S., Pres. R.M.S. 'On the elasticity and strength-constants of Japanese rocks,' by Thomas Gray, B.Sc., F.R.S.E., and

John Milne, F.G.S. 'The glacial deposits of West Cumberland,' by J. D. Kendall, C.E., F.C.S.'"

It would be the easiest thing in the world to fill four or five pages weekly with such reports. Indeed, it is easier to use them than to decline them; but however excellent such things may be in their place, we must point out that they would not at all correspond with the promises held forth in our prospectus. When we increase our space, it will be to find room for matter more likely to be widely and generally interesting. Of course, the papers read before our learned societies are full of interest for experts in the respective branches of science to which they belong; and their subject matter may be made very interesting by suitable treatment; but their mere names, or abstracts of their contents, could have no interest for the great majority of our readers. Even our scientific readers would only be interested,—each, perhaps, in one or two out of a dozen such titles or abstracts. RICHARD A. PROCTOR.

PROFESSOR CLERK MAXWELL AND THE REVERSIBILITY OF THE GRAMME MACHINE.

[83]—Listening to Professor Sylvanus Thompson's paper on "Storage of Electricity," at the Society of Arts, last Wednesday, I heard to my surprise the following story (as an introduction to his subject):—"Not many months before he was seized with the mortal illness which robbed us too soon of his rare and unique genius, Professor Clerk Maxwell was asked by a distinguished living man of science what was the greatest scientific discovery of the last twenty-five years. His reply was, 'That the Gramme machine is reversible.'"

Now I fully subscribe to Professor Thompson's statement about the loss we have sustained by Professor Maxwell's death, of his rare and unique genius; but the latter part of the above citation I listened to as to a story told of great men; one of those stories which often have their origin in insignificant incidents or expressions, and are used for the purpose of raising the subject of which the great man speaks in the estimation of the listeners, or are intended to give a certain halo to his fame, and show his abstracted, simple mind. A story of this latter category I heard told of Arago. To enable a favourite cat to enter his study, he had a hole cut in his door; and when this cat had a kitten, he had a small hole cut at the side of the big one, to give facility to the kitten also to enter. We may look upon such stories as the spice with which sometimes scientific subjects are dished up; and in that light I accepted the account of Professor Clerk Maxwell's opinion about the greatest discovery within the last twenty-five years.

But I was astonished to find this story printed in the paper as given in *extenso* in the *Society of Arts Journal*, and hence offered to the reader as an undeniable fact.

Professor Thompson's paper itself contains the reason, why one may doubt, that Professor Maxwell should have made such a reply seriously; and the reason is, that ever since Ritter built up his first secondary pile, or Jacoby his first electro-magnetic engine, or Pacinotti his electro-magnetic engine with the first ring armature—nay, since Newton's law, as given by Professor Thompson himself in his paper ("to every action there is an equal and contrary reaction"), was enunciated, there could be no doubt whatever that the Gramme machine was reversible. But, principally, it follows directly out of Leuz's law of magneto-electric induction, published in 1834, and could have been foretold from all practical experience made with the electro-magnetic power engine which was intended and expected, some thirty to forty years ago, to supplant the steam-engine.

We will set aside for a moment Newton's "immortal" law *per se*, and its application to the secondary battery; and take the phenomena of the electro-magnetic motor, and of magneto-electric induction alone, into consideration.

Clerk Maxwell, in his "Electricity and Magnetism," 2nd edition, section 530 (Vol. II., p. 167), gives the latter phenomenon in the following words (under the heading Magneto-Electric Induction):—

"In all cases the direction of the secondary current is such that the *mechanical action* between the two conductors is *opposite* to the *direction of motion*, being a repulsion when the wires are approaching, and an attraction when they are receding. This very important fact was established by Leuz." (Pogg. Ann XXI., 483.—1834.)

Surely no great logical powers are required to interpret this law, as, in fact, years ago it has been interpreted—viz., the same arrangement of conductors and magnets which, by motion in relation to each other will produce a current in the conductor, will produce motion when from some electric source a current is sent through the conductor.

This "reaction" was applied in some of the earlier forms of magneto-electric "induction machines," which were used for illustrating the application of electricity as a "moving power"; and Pacinotti, when describing his electric motor, in which the ring armature was for the first time applied (1860-64), stated already that, when rotating the armature, his machine could be used as a generator of electricity.

Lastly, Jacobi showed nearly fifty years ago (about 1835 or 1836) that the efficiency of electro-magnetic motors was seriously interfered with by the electric currents induced in the machine. Hence, ever since the production of electric currents by means of magneto-electric induction was understood, and since the application of electricity for the production of motion has been studied, there could not have been any doubt about the reversibility of a magneto-electric or dynamo-electric generator into an electro-magnetic motor. And this story of Professor Clerk Maxwell declaring this "discovery" as the greatest scientific discovery of the last twenty-five years loses, to say the least of it, its point.

Perhaps some of your readers can bring some further light to bear upon this question, and witnesses will be forthcoming to prove either *pro* or *con*.

I may incidentally remark here that Professor Thompson's paper was the most complete account which it is possible to give of the important question of the storage of electricity, as he has thoroughly exhausted the subject in its scientific and practical bearing, for which he deserves the thanks of every electrician and engineer interested in this latest phase of the development of the science of electricity.

Nov. 26, 1881. C. G. G.

SUNDAY ART EXHIBITION.

[84]—The exhibition of works executed by students of the City School of Art, which was opened on two Sundays in December last, having proved very interesting to a large number of people at the East-end of London, we have great satisfaction in announcing that arrangements have been made for again opening the exhibition on Sundays.

The Exhibition, which is the twenty-fifth Sunday Art Exhibition opened under the auspices of the Sunday Society, will be held in the Skinner-street Hall, Bishopsgate, and will be open from three to six o'clock p.m. on Sundays, Dec. 4 and 11. Admission will be free (without ticket), and we are pleased to be able to state that, in addition to the work of the students, some valuable pictures from the collection at South Kensington Museum will be exhibited.

In order that the widest publicity may be secured for this effort to provide innocent recreation on the leisure day of the week, we ask you to insert this letter in your columns, seeing that the facilities in London for visiting collections of art are far too limited, and that the want of open museums and art galleries on Sundays is especially felt by the inhabitants of crowded districts at this season of the year, when our climate so often practically closes the parks and gardens to them.—We are, &c.,

WILLIAM ROGERS, M.A., *Chairman.* } City School
R. H. HADDEN, B.A., *Hon. Sec.* } of Art.
THOMAS BURT, M.P., *President.* } Sunday
MARK H. JUDGE, *Hon. Sec.* } Society.

7, Conduit-street, W., *Nov.* 30, 1881.

THE PYRAMID AND PARADOXERS.

[85]—If I were called upon to classify paradoxers, according to the good or evil effects they have had upon the community, I should give the Pyramid craze a very honourable place, for it has served to carry a knowledge of certain elementary facts connected with astronomy and geometry into dark regions where attention to such matters would probably never have been aroused by other means. There are thousands, possibly I should be nearer the truth if I said hundreds of thousands, who would never have known that the pole of the earth's axis is moving amongst the stars if it had not been for the Pyramid paradox, and the literature which has sprung up around it. There seems to be something connected with such speculations which has a fascination for a large class who would be wearied by a more cautious search after truth. We have only to notice how a statement, that three of the major planets will be in perihelion next year, and, consequently, something extraordinary may be expected to happen on the earth, goes the round of English and Colonial papers, to see that such speculations are fitted to do a sort of missionary work for science.

I wish to enquire what attitude those who would like to see the scientific spirit spread, should take with regard to such speculations. There are some who think that this tendency of human nature may be utilised to obtain money for science; and they have not thought it unworthy of them, as seekers after truth, to pose before the uninstructed, as weather prophets or alchemists. Give us money to study the sun, they say, and we will tell your fortune by sun-spots. We will show that the elements are not elementary, and, perhaps,

XUM

in time, we may transmute them. I expect that there are a good many besides myself who feel that such a method of trading upon the paradoxical proclivities of our neighbours is not honest, and must not for a moment be indulged in. How, then, can we utilise the interest stirred up by such paradoxes to spread a love of science, and to bring to our neighbours all the benefits which follow from a patient search after truth?

It seems obviously unwise to ignore the paradoxers, or even unnecessarily to hurt their feelings and snub them, as some able men seem inclined to do. Paradoxing is an approach towards science, and, at all events, is better, and more worthy of being spoken of with respect, than purely selfish or unintellectual forms of enjoyment. Most of us are, no doubt, pretty frequently thrown amongst paradoxers, or with those whom we believe to be paradoxers. I would suggest that when we have made up our mind that our friend is a paradoxer, we should endeavour to put our objections to his paradox in the form of questions which raise difficulties that he has probably not yet considered. We may thus lead him on, and at the same time exercise ourselves in the art of seizing the difficulties of others.

Let us take an example. Mr. Baxendell, in your number for Nov. 18, says that he has been led to believe "that the data which formed the basis for the design of the great pyramid were the diameters and distances of the sun, earth, and moon, combined with the ratio π of the circumference of a circle to its diameter." He proceeds, let s = the diameter of the sun, e = the diameter of the earth, m = the diameter of the moon. Then we have

(1). $\frac{se}{m} = 1{,}000{,}000\pi$.

(2). $\sqrt{s}\,\pi^2$ = length of one side of the base of the Pyramid.

And then follow thirty-one more such relations. I will not occupy space by repeating them. We might commence by asking whether the relationships discovered refer to the solar system at its present temperature, or to the temperature which its various parts had at the time when the Pyramid was designed. Let us suppose our imaginary pyramid paradoxer to answer that the relationships must be true for the temperatures and magnitudes of the designer's epoch. We might then proceed to inquire whether the probable errors in the determinations of the quantities made use of in the equations are sufficiently small to enable one to determine whether there has been any change of magnitude in the various parts of the solar system since the Pyramid epoch. The answer to this question will give an excellent opportunity for inquiring into the amount of the probable errors in determining the height of the Pyramid—the length of its base—and other pyramid magnitudes, compared with the probable errors in determining astronomical magnitudes. If we succeed in convincing him that the moon's distance can be determined with greater accuracy than the height of the great Pyramid, the rest is easy. It follows that there can be no advantage in attempting to determine astronomical quantities from pyramid measures.

But let us suppose that our companion is not sufficiently acquainted with astronomical methods to understand such reasoning. We can point out to him that the relationships he has found are not homogeneous. His first equation is equivalent to the statement that a length multiplied by a length is equal to a length multiplied by a number. Such a relation between quantities can only be true when a particular unit is used; and we can point out that all relationships in nature can be expressed so as to be true, whatever unit is used. We may then show him that his different equations involve different units; for example, his second equation involves the use of Pyramid miles on the one side, and Pyramid inches on the other.

In such a conversation, do not on any account refer to authority or endeavour to crush your opponent with facts that he cannot verify for himself, but patiently plod on, using your ingenuity to utilise the interest in the study of nature which has been begotten in his mind by the paradox, and, if possible, stir up his enthusiasm for the further study of such things, and endeavour to leave him with a sense of your perfect fairness and an appreciation of the scientific method which you strive to apply in satisfying yourself as to truth,

A. C. Ranyard.

Nov. 28, 1881.

PYRAMID MEASURES.

[86]—I do not profess to be master of the whole theory of probabilities, and it is perhaps owing to this that I have failed in my attempts to apply it in proving that the coincidences given in my paper are merely accidental. So far as I understand the theory, and have been able to apply it, the results indicate in a marked manner that the coincidences are *not* accidental, and, therefore, till the contrary can be shown, I think I am justified in my conclusion "that so far, at least, as the values of the distances and diameters of the sun, earth, and moon are concerned, modern science has made no real advance upon the science known to the builder of the Great Pyramid four thousand years ago."

The subject is one of considerable interest and importance, and, whether I am right or wrong in my conclusions, I shall be glad to see it fully and impartially discussed in Knowledge, and leave it to be decided from the results of such discussion whether it is desirable to enter into the questions of inspiration and prophecy. At present the general feeling appears to be decidedly against the coincidence theory, and the very few who object to the inspiration theory argue that in remote ages a high degree of civilisation existed, and that knowledge had been acquired which, when men afterwards relapsed into a state of superstition and barbarism was almost entirely lost. But on this theory the question again rises, In what way did men in those early times acquire this knowledge, and what evidence have we of its existence except that shown in the Great Pyramid?

I am, dear sir, yours faithfully,

Joseph Baxendell.

[87]—I venture to offer an explanation of the remarkable numerical relations between different parts of the Great Pyramid, pointed out by Mr. Baxendell in your number of Nov. 18, more probable, I think, than the supposition that its ancient builders had anticipated the discoveries of modern astronomy as to the distance of the sun and moon and the size and shape of the earth, but buried their marvellous attainments in a mass of stone-work, with no explanation, till, thousands of years afterwards, they were brought to light by the indefatigable zeal and scientific skill of Professor Piazzi Smyth.

The measures are, I believe, founded on astronomical observations, but observations of the most primitive character—the length of the year, the length of the month, the length of the week, and, what appears to have symbolised the course of time, the number 60, which meets us in the 360° of the zodiac, the 60 hours in India, and, I believe, also in Egypt, of the day, 60 minutes of the hour, 60 seconds of the minute, &c.

It seems to me impossible to reason with any assurance on this matter unless we knew more certainly than we do what their calculations were. We cannot ascertain this positively from the actual measurements, unless we assume that the old builders measured as accurately as Professor Piazzi Smyth, which is very improbable. It is quite possible that if we had the plans of the architect before us, we should find relations simpler than those stated above.

There is no necessity for attributing to the Egyptian builders any preternatural knowledge of astronomical facts in order to account for the peculiar relations subsisting between the measures of the Great Pyramid.—Yours, &c., G. Vansittart Neale.

[We have been obliged to omit the numerical relations indicated by Mr. Neale. They correspond with the measurements as well as others which have been devised. One could explain the proportions of the Pyramid in a dozen different ways.—[Ed.]

POSSIBLE DAILY VARIATION OF PENDULUM.

[88]—There is a question that I have long thought might be worth trying respecting the earth's motion. In round numbers, say, the centre of the earth travels round the sun at the rate of 1,000,000 miles per day, or say 40,000 miles per hour; and the earth revolves at the rate of 1,000 miles per hour. One side of the earth will be going at the rate of 40,000 miles + 1,000; the other side 40,000 miles − 1,000; difference of velocity to be imparted in 12 hours, 2,000 miles per hour.

If a heavy and steady pendulum of great length were properly suspended and protected, some daily motion might be discovered, due to this varying velocity being communicated through the suspending-rod. The direction of revolution round the sun and the earth's revolution are both known. Perhaps some indication of some other motion might be found. A long pendulum would be essential. This, I apprehend, would not be so much affected by minute, rapid tremors, but would more clearly show the action of long duration. My own experience has been only with transits and other instruments in engineering work.

No. 1 of Knowledge has been sent to me to-day, as a sample, I presume. I shall take it. Receiving this has led me to trouble you with these remarks.—I remain, yours truly,

Henry Carr.

DARWIN'S THEORY OF EVOLUTION.

(*Abstract, much condensed.*)

[89]—Sir John Lubbock, in his able and luminous address delivered before the British Association at York, told us that we ought to believe "that the horse and the ass, the sheep and the cow proceeded from common ancestors." I cannot find a tittle of

satisfactory evidence to prove the conclusion advocated by Sir John Lubbock. Let us take a single instance of Mr. Darwin's "method" of treating facts and inferences. He tells us that the rattle of the rattlesnake was probaby evolved by the desire of the creature "to frighten its enemies." [Darwin says nothing about the rattlesnake's *desire*.—ED.] Now the "enemies" of any animal seek it out in order to attack and destroy it; and, therefore, the rattle, so far from being a source of alarm, would act rather as an invitation to the snake's "enemies" to pursue and overcome it. [How if they dislike the noise?—ED.] Further, if the desire to frighten an enemy is a creative cause of such an organ as a rattle, why does not the same desire develop the same product in other creatures? A similar cause ought to produce a similar effect under similar conditions.

Sir John also alluded to those known transformations which occur in a short time, and which have been observed in many objects of creation; and he cited them as collateral testimony of those greater and more profound transmutations which have been supposed to be wrought in higher organisations during remote ages. I submit that this argument is altogether illusory. Those obvious minor transformations, to which Sir John referred, take a certain course—pursue a certain round—in obedience to regular processes and laws of being, and then terminate their career under known conditions.

The attention of the audience was also invited to the circumstance that the stripes of the tiger correspond with the long grass in which he makes his habitat; and that the spots of the leopard resemble the speckled appearance of the light falling through the leaves of trees. Now, if this eminent teacher really means that we should believe that in these instances the long grass and the specks of light are in the remotest degree the *causes* of the stripes of the tiger and the spots of the leopard, then I must say that the impression he wished to create is the most astounding and intolerable tax upon our credulity ever levied by the greatest scientific fanatic.

London, *Nov.* 19, 1881. NEWTON CROSLAND.

[Mr. Crosland entirely misapprehends the Darwinian theory and Sir J. Lubbock's remarks on it. We feel justified in excluding objections based on mere misinterpretation of the theory attacked; though inquiries suggested by such misinterpretations will always find a place here.—ED.]

PROBLEMS GEOMETRICALLY INSOLUBLE.

[90]—Would the geometrical solution of one or two problems, hitherto unsolved by geometry, be suitable for the pages of KNOWLEDGE? One is to determine the centre of gravity of a semicircle, and a computation of its distance from the centre of the circle by trigonometry. This, of course, is analogous to what is called squaring the circle.

Another is to determine the diameter of a sphere equal in volume to a given parallelopipedon. I should esteem it a favour if you would let me know what you think about them.—Yours, &c.,

J. G. MOORE.

[The trigonometrical computation of the centre of gravity of a circular arc is well-known. If our correspondent knows of any simpler form of it, we shall, of course, be glad to have his demonstration. If, as a preliminary to either of his problems, he proposes to "square the circle" geometrically, we shall be content to wait awhile. If he *has* squared the circle geometrically, we shall never succeed in showing "where the error comes in."—ED.]

A REMARKABLE RAINBOW.—LOGIC *versus* MATHEMATICS.

[91]—About three o'clock in the afternoon, one day last week, I observed a very bright rainbow, accompanied by its secondary external arc. To my great surprise, I noticed that the primary bow consisted of a triple series of colours, the red of the second band being in close contact with the violet of the first, and so with the third. The colours of the third band were very faint, and it was only distinctly visible for a short time at the summit of the arc; but the second band was visible over almost the whole length of the bow for three or four minutes. I should be glad to know whether this phenomenon has been noticed before, and how it may be explained.

I am rather sorry to see that, notwithstanding the warning of "F.R.A.S.," in No. 1, your admirable paper is being seized upon by the crotchet-mongers to air their remarkable notions, and I trust you will not think that I wish to dispute accepted and infallible laws of mathematics or of logic because I send you a paradox in which they appear to confute one another. My paradox is as follows:—

For every whole number there is a square, which is also a whole number. No two whole numbers have the same square.

Therefore there are as many whole numbers which are squares as there are whole numbers.

But there are many whole numbers which are not squares to other whole numbers.

It follows that there are whole numbers which are not whole numbers.

I prefer, however, to infer that the series of numbers being infinite, and the series of their squares being therefore also infinite, the latter infinity includes the former. I should like, however, to see a more satisfactory explanation.—Faithfully yours, THETA.

[We do not see how there can be a more satisfactory explanation than the one "Theta" has himself supplied. If we consider any corresponding parts of the two series, 1, 2, 3, 4, &c., 1, 4, 9, 16, &c.; we see that, taking them together towards infinity, the latter will run on to a higher infinity, as it were, the highest number in the latter series being always the square of the highest number in the former. Or, algebraically :—$\frac{1^2+2^2+3^2+\ldots\ldots+n^2}{1+2+3+\ldots\ldots+n} = \frac{\frac{1}{3}n(n+1)(2n+1)}{\frac{1}{2}n(+1)} = \frac{2n+1}{3}$ or is infinite when n is infinite.—ED.]

STONE ON WHEELS.

[92]—The results obtained by "Queensland" and his mathematical friend (Query 28, p. 80), with regard to the stone rolled on wheels, probably differ through their not understanding each other. If "Queensland" means the wheels to be supported by and revolve on fixed axles, then the stone will move, as he supposes, through a distance of 75 in. If, however, he intends the wheels to rest on the ground, they will themselves move along a distance of 75 in. for each revolution, carrying the stone with them, and at the same time they project the stone forward (with regard to their own position) an equal distance; it will, therefore, move a total distance of 75 in. + 75 in. = 150 in. G. M.

POLARITY *versus* GRAVITATION (*Abstract*).

[93]—I AM too old a stager to take umbrage at any usage, however rough, which I may experience in the arena of debate; when, therefore, you tell your readers that I am "a paradoxer," who hardly knows what he is about, I accept the imputation in the parliamentary and controversial sense in which it is meant. I presume it is your mode of saying that you differ from me in opinion.

My ideas must naturally suffer some loss of cogency by the necessity which exists of compressing their exposition within the space which you have kindly allotted to me.

Permit me to submit a few words of reply to your remarks on my letters. With regard to my objections to the Newtonian theory of the tides, as you merely content yourself with reiterating that theory, and asserting its correctness, I can, of course, say nothing more on this subject. Discussion becomes profitless when one disputant sets up what the other knocks down.

Touching my criticism on the centrifugal and centripetal forces as regulators of the motions of the universe, I beg leave to say that "the ill-informed writers" who used the term "centrifugal force" in the sense which I condemned are Joyce, in "Scientific Dialogues;" Milner, in "The Gallery of Nature;" Ferguson, in his "Lectures edited by Brewster;" Dr. Lardner, in his "Astronomy;" and "Keith on the Globes"—all well-known expounders of the Newtonian system—and Sir Isaac Newton himself. When you say that "centrifugal force is only another way of viewing the centripetal force," I know what you mean, but I fancy that the general reader will require further explanation. The revolution of a planet round the sun is supposed to be effected by the attraction of gravitation or centripetal force of the sun drawing the planet out of the straight line on which it was first impelled by its Maker.

In one part of its orbit the sun draws the planet nearer to itself, and thereby accelerates its speed. This increase of speed is supposed to generate "a centrifugal force" which has a repellent effect, and thus sends the planet off again on its proper course. Now, here comes in the ticklish part of this theory. When once the attraction of gravitation overcomes a rival force, nothing can stay its career of conquest, except the intervention of a third power of equal potency and independent jurisdiction. As the accelerated speed above-mentioned has no such independent origin, but proceeds directly from the centripetal force which draws the planet towards the sun, the planet cannot, by any struggle of a centrifugal force, escape from the catastrophe of ultimately being precipitated upon the face of its ruler, and there terminating its blundering career. Fortunately for us, the planet knows better, and obeys the law of polarity, not that of gravitation. I submit that my theory of polarity—attraction and repulsion—gets rid of the difficulty here so patent, and enables us to arrive at a sounder idea of the laws of revolution.

I now leave my ideas to their fate. If they are good for any-

XUM

thing, they will flourish; if they are worthless, they will die. I should consider them of not much value if I thought they would generally be accepted without a hard battle.

It may perhaps be as well to inform the general reader that my views do not in any way affect the working of those mathematical problems which are based upon the facts and phenomena of Nature.

NEWTON CROSLAND.

THE FAURE ACCUMULATOR.

[94]—As one who has read and recommended several friends to get KNOWLEDGE, might I ask a favour?

Much mention has lately been made of the "Faure Accumulator," and the benefits likely to accrue by this addition to electrical appliances, but I, like a good many more, have no very clear or precise idea as to what this invention is.

Would you therefore give in a future (and let me hope near) number of KNOWLEDGE, an account and description of it?

A SCIENTIFIC SMATTERER.

FAURE ACCUMULATOR.—GRAVITY.

[95]—Would you kindly furnish me with a short account of the construction and mode of action of the Faure Accumulator? also, if not asking too much, the proof, or where it is to be found, of your statement concerning gravity, on page 59, No. 3, of KNOWLEDGE?

G. T.

PRACTICAL WORK WITH THE TELESCOPE.

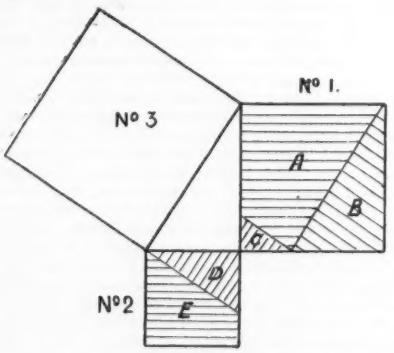
[96]—In reply to your correspondent "G. M.," letter 39, I would suggest for his use the Rev. T. W. Webb's "Celestial Objects for Common Telescopes," new edition, and R. A. Proctor's "Larger Star Atlas," 4th edition; and that he might do very useful work in carefully observing and recording the colours of stars, and the changes of brightness of some of the variables.

With best wishes for the success of KNOWLEDGE, I am, dear Sir, yours faithfully,

JOSEPH BAXENDELL.

THREE-SQUARE PUZZLE.

[97]—The enclosed has never been published in any book or periodical, but you are welcome to insert it in your paper, KNOWLEDGE, if you think well to do so. If a piece of cardboard is cut into the five pieces, A B C D and E, it is not easy to form the third large square with them. This makes a good puzzle for Christmas.



Arrange the five pieces A B C D E, which compose the two small squares Nos. 1 and 2 into a single square, No. 3. This, when done, is a mechanical proof of the above proposition.—Yours &c.,

ALF. A. LANGLEY,
Engineer-in-Chief, Great Eastern Railway Co.

REPORTS OF SOCIETIES.

[98]—Truly, as the "announcement" of KNOWLEDGE was originally gratifying to those who seek it, and equally as truly as the publication itself proves so, still, you will not wish the compliment of having got "one subscriber" to be often repeated to you. In my humble case I ordered three on "spec" of No. 1 before publication, and at once posted one off to the Australian up-country—the latitude somewhere where you did see what "Parallax" says not.

And after saying this, may I find a little fault? I will venture. It is in the omission of any chronicle of the proceedings of the learned societies, both home and foreign. For instance, the Meteorological met on the 16th, and discoursed on the big storm of Oct. 14. Now, sir, this feature is a great desideratum, and, therefore, let me urge it strongly; and also that the reports, however brief, be systematic and real. There surely would have been something most interesting to report concerning Professor Thompson on the "Storage of Electricity." And even the mental science societies should not be left out in the cold. The "Aristotelian," for instance, could tell the world briefly of its goings on in the "knowledge" of its mind-work.—Yours, &c., J. F. S.

AQUEOUS VAPOUR.

[99]—In letter 20, on page 56 of your welcome paper, G. F. P. Dyer makes a statement about aqueous vapour, of which I venture to question the accuracy. He says "that aqueous vapour has the power to absorb rays of heat coming from the *earth*, but is incompetent to absorb rays from the *sun*." Now, in "Heat as a Mode of Motion," Professor Tyndall states (paragraph 684) that experiment proves that the aqueous vapour of the atmosphere absorbs about four-tenths of the heat radiated from the sun towards the earth. Has subsequent experiment disproved the Professor's conclusion, or has Mr. Dyer made a mistake? I think in this case Dr. Tyndall must be right. H. P.

[H. P. will find, on more careful reading of paragraph 684, that Dr. Tyndall does not say exactly what H. P. has stated above. It is, however, true that aqueous vapour absorbs a portion of the sun's heat-rays, but in much smaller proportion than it absorbs the obscure heat-rays from the earth.—ED.]

FLOWERS OF THE SKY.

[100]—May I take the liberty of calling your attention to certain passages in your work, "Flowers of the Sky?"

In page 2, the velocity of light, "at a rate exceeding more than ten million times the velocity of the swiftest express train."

In page 15, "that light carrying its message at a rate exceeding six thousand times the velocity of the swiftest express train, would be utterly unable to give a true account of the position and movements of the celestial bodies."

Again, in Figs. 17 and 18, the remarks that apply to 17 belong to 18, and *vice-versâ*.—Yours, &c., WILHELMINA K.

[I have not the book by me, but, unless I mistake the passage at page 15, it does not indicate what the velocity of light is, but a velocity which, though enormous, would utterly fail to do what light does. Figs. 17 and 18 got interchanged somehow after the book had been passed for press.—ED.]

INTONATION IN SYNAGOGUES.

[101]—In answer to your correspondent "G. P." The accents in the Hebrew Bible supply the place of musical signs. Warschawski, in his "Progressive Hebrew Course and Music of the Bible," (London: Longmans, 1870), gives a series of equivalents for each of these accents in modern musical notation. For the accents themselves, see any large Hebrew Grammar. With regard to what may be called a cognate matter, the chanting of the Koran, Lane, in his "Modern Egyptians," gives the musical notes which would express the mode in which the first chapter is chanted. There are, of course, full treatises in Hebrew and Arabic on these subjects, from which deductions could be drawn: this, however, would require much patient research. W. A. S.

A NEW COMPARISON OF POISONS.

[102]—In your last number (No. 4) you give an abstract from the *Times*, quoting the result of a number of experiments of the action of poisons in solution upon fish. Is there not some mistake in relation to the poisonous properties of lithium and barium. The paragraph runs thus:—Lithium (atomic weight 7, not 17), with an atomic weight only the twentieth of that of barium, is three times as poisonous. Now, it is generally known among chemists that barium (especially the chloride) is an exceedingly poisonous metal (or salt), whereas lithium, even in comparatively large quantities, is not poisonous, the citrate, for instance, being often prescribed for gout.

I think some mistake must have been made in copying the original, which, of course, is no omission on your part, it being merely an abstract. Wishing your valuable journal all success.—Yours, &c., TECHNICAL CHEMIST.

[The "copy" was the paragraph itself. Thanks for pointing out the inaccuracy. Newspaper science needs such correction, as we know from articles and paragraphs on subjects more especially our own than technical chemistry.—ED.]

EVOLUTION—STAR-MAPS—BRITISH MUSEUM.

[103]—While defending, to the best of my ability, the theory of evolution, I have been asked the following question, which I have been unable to answer: "If man be an 'evolved' being, why has he not improved?"

I should like to be informed whether—(1) Since man has existed has the process of evolution effected any change in him? (2) If so, what change? (3) If not, why not?

With reference to your star-maps, you say in No. 4 of KNOWLEDGE that the times given in Nos. 1, 2, and 3 are one hour out, but that the error is corrected in No. 4. Yet taking the same dates, the times in No. 4 agree with the others. I would be glad if you would explain this.*

Could you, or any of your readers, inform me on what conditions and by what means admission can be gained to the British Museum library and reading-room?† G. M.

PROTECTING HOUSES FROM LIGHTNING.

[104]—I wish to protect a square house which has nine chimneys, all of equal height, from lightning, by means of two iron rods 3 ft. above two of the *centre* chimneys, connected with the iron water-pipe which supplies the cisterns from the main, by a galvanised iron wire conductor. Will you kindly tell me if this protection will be sufficient, and whether I have chosen the right chimneys. I prefer using the *centre* ones, as the conductors will be less conspicuous than if they were placed on chimneys *near the corners* of the house, the roof being nearly hidden from view by a parapet. I am delighted with KNOWLEDGE, but I wish you would print the names of the stars of the first and second magnitude on the map. B.

A QUESTION OF GRAMMAR.

[105]—Is "Nameless" (query 24) correct in writing "*would* the editor," &c.? Should not he have written "*will* the editor"? "Nameless's" mode of asking his question, I know, is frequently adopted, and my eye just now lights upon a letter in the *Guardian*, where the writer has "*might* I call your attention," &c. Would not *may* have been the proper word? Again, "I cannot but think" is an expression of every-day occurrence, and I presume right; but is "I can but think" wrong? "I can but think" seems only another way of saying "I can only think," which is also of common occurrence. If "I can but think" is not wrong, then we have both expressions, one with the negative, and the other without, meaning the same thing. We have the word "annul" and also "disannul," both meaning much the same thing, but "dis" is not used as negative, but as intensive. Would that be the case with the word "not," in the first instance? A. T. C.

THE MISSING LINK.

[106]—Mr. Wilson, in Letter 33, admits "where the links that connect man to his lower neighbours are to be found is a difficult question to answer," but until it is answered satisfactorily, I am afraid that common ignorance (?) will continue to ask the unfortunate question. One evolutionist to whom I put the question answered that he supposed the remains were all under the sea.

It seems to me that evolutionists would call every one that does not agree with their dogmatical statements an ignoramus.—I am, &c., ANOTHER IGNORAMUS.

THE MISSING LINK (*Abstract*).

[107]—I approach a criticism of Dr. Wilson's remarks (p. 74, No. 4) on the "Missing Link" with a nervousness that is only equalled by my desire to know and possess the truth respecting the circumstances surrounding the case.

Your correspondent, "Ignoramus," if not satisfied as to the foundation of evolution, has, I think, a right to ask for that which evolutionists declare exists, and is the only foundation upon which evolution is said to exist.

Professor Huxley ("Encyclopædia Britannica," 9th edition, vol. iii., p. 690) speaks thus: "The only perfectly safe foundation for the doctrine of evolution is in the historical, or rather archæological, evidence that particular organism, have arisen by the gradual modification of their predecessors (which is) furnished by fossil remains." Similarly Bastian, Darwin, Herbert Spencer, and others.

Now I ask for one species from the lowest to the highest strata in any of the geological periods that have been transformed into another?

Secondly, if the truth of evolution rests on fossil remains ("Missing Link"), where are those fossil remains? Where found? Who found by? Where are they now? Hæckel, Buchner, Darwin, &c., have failed to find or give any. Evolution's foundation does not rest on rudimentary organs, but on fossil remains.

I only plead for what evolutionists declare has led them to teach and hold the doctrine of evolution. To tell me that the fossil remains are gone down to the bottom of the sea—that where men first lived is all ocean—is to mock me in my earnest cry for more light.—Yours, &c., MITCHELL.

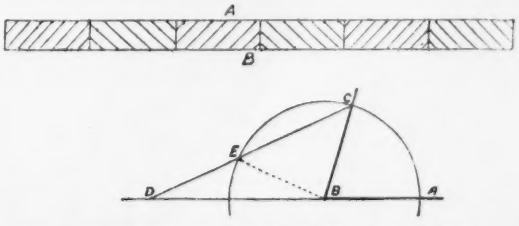
KNOWLEDGE FOR THE YOUNG.

[108]—I am very pleased with KNOWLEDGE, and am endeavouring to make my children like it. Parents do not sufficiently estimate the importance of watching boys' literature. I have great difficulties before me, but if, when my boys are young men, these difficulties right themselves, I may be satisfied, but not before. The penny weekly journals started within the last few years by the Religious Tract Society and others, professed to supply an improved literature, but I fail to see it in such brutal tales of adventure as "From Powder-monkey to Admiral," &c. Boys eagerly read them, and the principles they learn are carried into practice in their every-day life. The few chapters similar to those in KNOWLEDGE are not read at all. I find it much easier to read "The Land of the Midnight Sun," with the map before me, to my boy aged nine, than to get his elder brother to look at it—he is too busy over some tale of the "to be continued in our next" class. I was really astonished to watch the interest the younger boy took in Darwin's book on worms, which I read to him, and he has since studied their habits to a surprising degree. How, then, will it be possible to rectify the mischief already done by the penny journals? Can you offer a column of inducements to boys for short essays on scientific or natural history subjects suited to certain ages (with permission to consult a parent or guardian in the composition)? It seems to me this would bridge over the difficulty I am now experiencing with the two elder of my eight children. Wishing your magazine much success. R. GILL.

[We fear it would not be possible yet to give a column to short essays by boys; but possibly a column or two especially for boys would be a useful addition.—ED.]

KNOWLEDGE—ILLUSION—TRISECTING AN ANGLE.

[109]—In addressing you a few words of congratulation on your success in producing KNOWLEDGE, I beg to suggest that there are a great many questions which may be elucidated in it (such as the method used by the American meteorologists in predicting storms, the present theory of the spectrum colours as differing from that taught in ordinary text books, papers on biology, &c.) which are *caviare* to the general public, and, therefore, exactly fitted for its pages, even at the risk of crowding out chess and whist, which are very fairly dealt with in the ordinary magazines, and hardly come within the special scope of KNOWLEDGE, as it seems to me. However, the many must be studied, of course. I personally should like to see it exclusively devoted to the dissemination of sound natural science, hence this hint. Your interesting notes on illusions have recalled to me the following, wherein the oblique lines enclosed within the parallel straight line *A* and *B* cause the latter



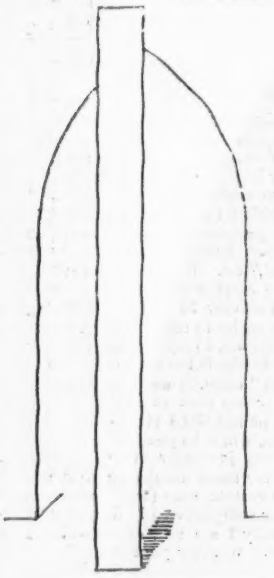
to appear zigzag instead of straight—which they really are. I send also a mechanical way of trisecting an angle, in reply to Query No. 48, thinking it cannot be done by pure geometry. It was got by me from "Wormell's Plane Geometry," and I find it quite correct for angles under 120°. *ABC* is the angle to be trisected. From *B* draw a semicircle, as in the figure. Then mark off the radius used for the semicircle on the straight edge of a piece of paper, which must then be placed so that the edge cuts through

* When we wrote as above, we supposed our correction was in time; but, as a matter of fact, the map, which, to ensure perfect blackness, was printed separately, had been for hours in the machine-room, and nearly half the impressions had been already struck off when the correction was made.

† By letter to chief Librarian, accompanied by a letter from a householder, certifying respectability, and stating objects of applicant: age must be over twenty-one.—ED.]

the point of intersection *C*, and so that one of the two marks on it lies in the semicircle, and the other in *AB* produced, as in *E* and *D* respectively. The point *D* thus obtained gives the angle *CDA*, which is the required third of *ABC*. The proof is interesting. For the exterior angle *ABC* is = *C* + *D*. But since *BC* is = to *BE* and to *ED*, the angle *BCE* is = to *BEC*, and this to *EBD* + *EDB*; that is, to twice the angle *D*. Therefore *ABC* is equal to 3 times *D*.—Yours, &c., James Warren.

SINGULAR ILLUSION.



[110]—A singular and practical illustration of the optical illusion, Fig. 2, of Mr. Foster's came under my notice a short time ago. The tower-arch of a church had been rebuilt, and during its construction a tall strut was set at an angle to the base, with its head fixed against the wall just above the apex of the arch. Whilst standing at the chancel steps, the arch presented a most singular appearance, and I called the contractor, who looked somewhat alarmed and astonished, and we both thought the arch must have dropped on one side. The accompanying drawing will explain what we saw. The pointed arch shows better than the semicircle the apparent illusion of the two lines belonging to different circles. F. Long.

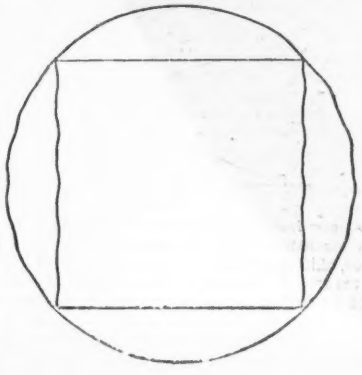
In order to make the illusion more plain, the strut is drawn out of proportion.

ILLUSIONS.

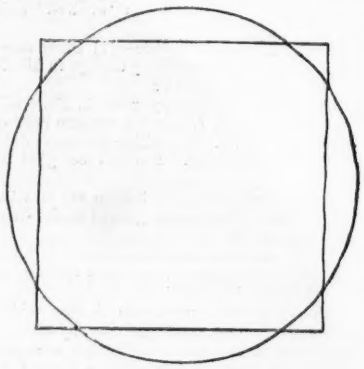
[111]—A few remarks upon the paper by Mr. Foster, on "Illusions," may be of some slight interest. The effects which angular, curved, and straight lines, in juxtaposition, have upon one another with respect to the eye are certainly very curious, and few eyes will fail to perceive the apparent distortions in the cases figured. I should like to remark, however, that in Figure 5, to my eyes, and to those of the one or two persons to whom I have presented the figure, the effect of the curves on the straight lines is just the reverse of that stated to be the case by Mr. Foster.

In Figure 6, to my eyes the straight lines AB and CD appear nearer in the middle, and EF and GH appear farther apart in the middle, thus agreeing with what is stated, and being the *reverse* of the two previous pairs of lines, which is what one would expect. I cannot by any method of gazing cause the straight lines in the last two pairs, Figure 7, to appear anything but parallel.

Below will be found a figure which shows the "flattened" appearance of a circle at the four corners of an inscribed square—a distortion of the same nature as that shown in Figure 3.



The figure beneath shows the same effect on the circle, and also gives the square the appearance of being drawn in at the middle of each side. Both these effects are shown much better



with larger figures. All these diagrams form pregnant comments on the oft-repeated adage: "Cannot I believe my own eyes?"—I am, yours, &c., Harry Grimshaw, F.C.S.

Clayton, Manchester, *Nov.* 21*st*, 1881.

CIRRUS CLOUDS.

[112]—In reply to "Anti-Guebre" (letter 2, p. 15), scientific men believe cirrus clouds to be composed of ice crystals because no other reasonable explanation is available. These clouds are found to produce certain optical effects upon light transmitted through them which can only be explained by the theory of their crystalline nature, ice being the only substance which will produce the observed phenomena under the conditions. This can be mathematically proved. In conclusion, I would ask your correspondent, Mr. G. F. P. Dyer (letter 20, p. 56), to refer to page 463-4 of Tyndall's "Heat," where it is stated that the aqueous vapour of our air does absorb a very considerable amount of direct solar heat, about four-tenths of the entire radiation; these being chiefly *dark* rays, which are the most effective as regards heating purposes.—I remain, sir, yours truly,

Birmingham. T. J. Hickin.

VIVISECTION. INJURIES TO THE BRAIN.

[113]—Most people think that of all cruel operations upon animals, that of cutting the brain is beyond all the most cruel. The first two extracts from recent numbers of the *Lancet* may modify their opinion. The third extract is from "Body and Mind," by Henry Maudsley, *M.D., F.R.C.P., &c., &c.*

G. A., aged 15 years, met with an accident by which one-half of the scalp was torn from the skull, which was itself fractured. From between the edges of the broken bone, brain substance was oozing, and this kept on for thirty-six hours. Recovery took place. The points to be noticed are:—

1. When the boy was found, he had already walked sixty yards without any assistance from the place in the coal mine where his head was crushed between a waggon and a rock, which forms the side of the "waggon way," and he afterwards walked home.

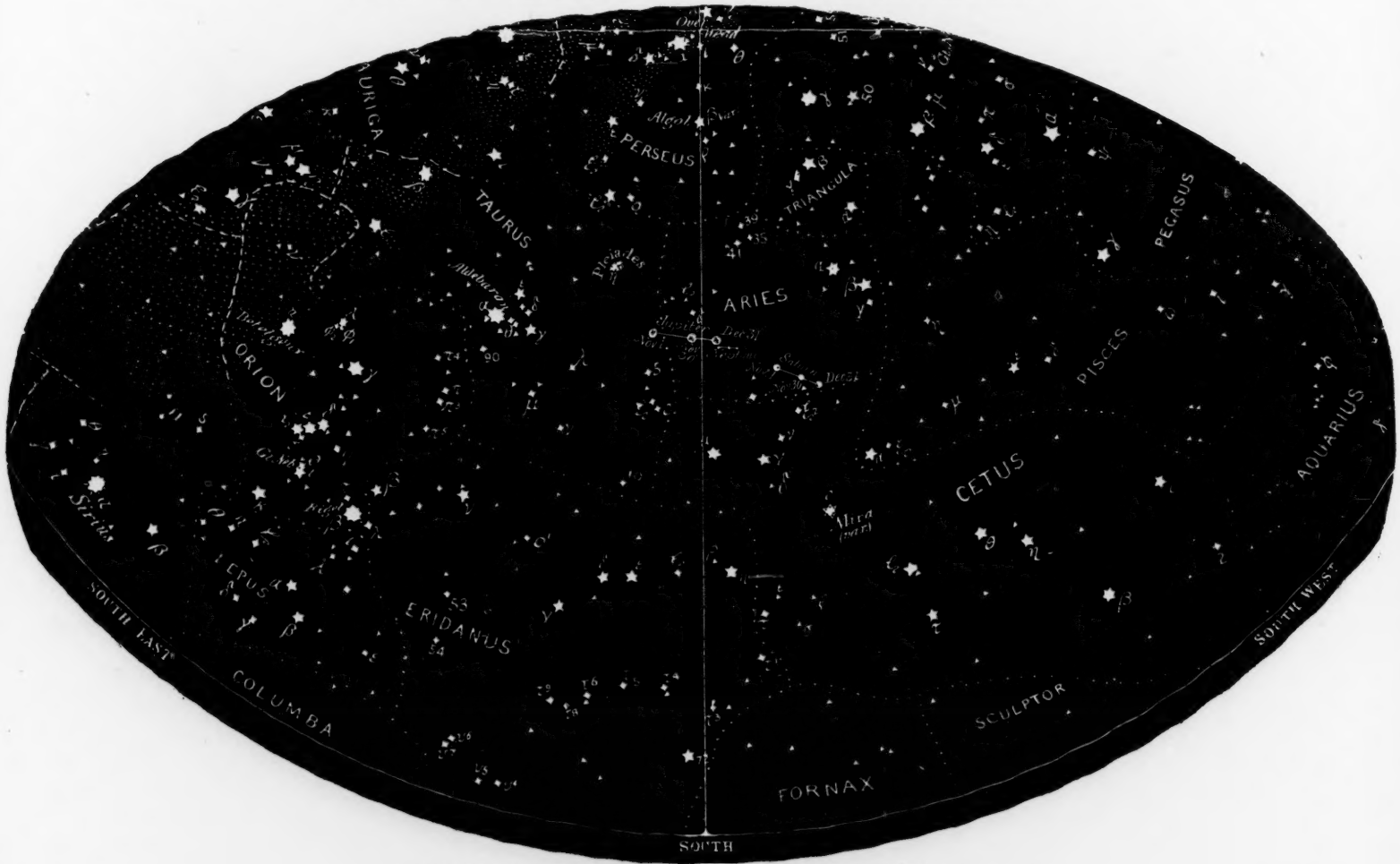
2. Although the injury was inflicted on March 6, 1880, the intellect is not impaired or mind affected in any way.

A man, aged 44, in an attempt at suicide, sent a small dagger through his skull into the brain. He had held the dagger in his left hand, and given it with the right several blows with a mallet, believing that he would fall dead at the first blow. To his profound surprise he felt no pain. He struck the dagger in all about a dozen times. When seen, about two hours after, the handle was projecting, 9 centimètres of the blade being sheathed in the head. For half-an-hour unsuccessful attempts were made to get the dagger out with a strong pair of pincers, the patient being held firm on the ground by two vigorous persons. The patient, who walked well and complained of no headache, was taken to a coppersmith's, and the dagger fixed to a chain passing over a cylinder turned by steam power. The man was fastened to rings in the ground. At the second turn of the cylinder the dagger came out; the patient, who had submitted to these manœuvres, suffered no pain or inconvenience. He walked to the hospital, remained there for ten days without fever or pain. He then returned to his work, and the wound healed.

R. E. Williams.

[*Continued on page* 121.

THE SOUTHERN SKIES IN DECEMBER.

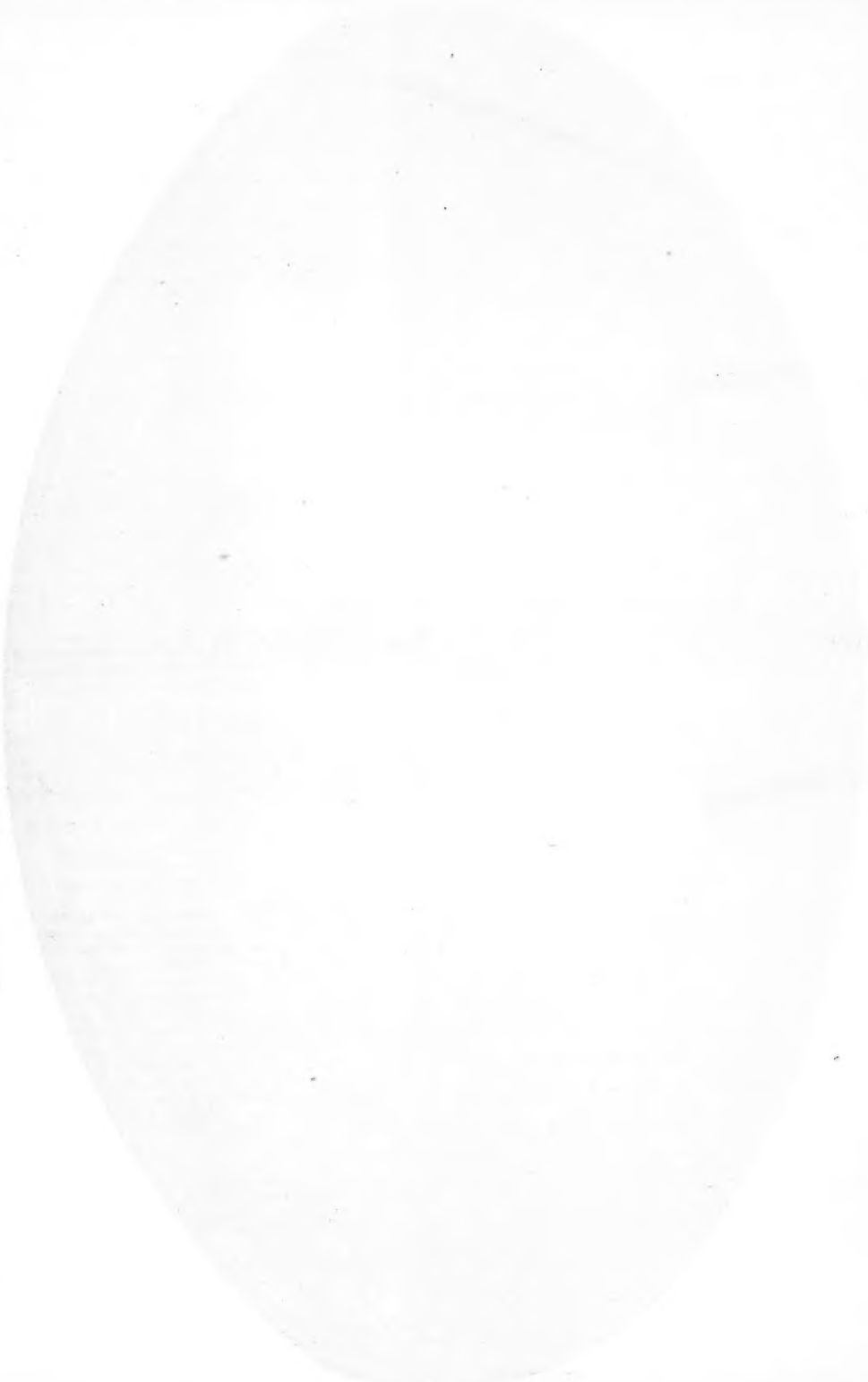


This Map shows the position of the stars in the Southern Skies: —

On November 30, at 10½ o'clock.	On December 8, at 10 o'clock.	On December 16, at 9½ o'clock.	On December 23, at 9 o'clock.	On December 30, at 8½ o'clock.
On December 4, at 10¼ o'clock.	On December 12, at 9¾ o'clock.	On December 19, at 9¼ o'clock.	On December 27, at 8¾ o'clock.	On January 3, at 8¼ o'clock.

The movements of the planets Jupiter, Saturn, and Neptune, now travelling in this part of the stellar heavens, are indicated by the lines marked with these planets' names. All these planets are retrograding, but less swiftly than last month, when, as explained in No. 1, they passed their respective points of opposition. The stars in the southern skies move across from left to right.

*** Stars of the first magnitude are shown with eight points, those of the second with six, of the third with five, of the fourth with four, of the fifth with three.



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Continued from page 118.]

BRAIN AND BRAIN CASE.

[114]—In Letter 42, page 78, of KNOWLEDGE, Charles Hamilton asks three pertinent questions. Leaving you to answer the first two as you best can, allow me to make a few brief remarks on the last, viz., "Does the brain shape or mould the form of the cranium or skull?" Dr. Lawrence, late Professor of Anatomy and Surgery to the College of St. Bartholomew's Hospital, London, in his "Lectures on Man," says of the skull that "the general capacity and particular forms depend entirely on the size and partial development of the brain." While Dr. Mayo, late Professor of Anatomy and Surgery to Royal College of Surgeons, in his work on "Human Physiology," after considering the relation between mind and brain, says, "Then it is certain that the skull is formed after the brain, and moulded upon it; and that very moderate attention will enable an anatomist, for the most part, to distinguish those prominences which are caused by inequalities of bone from those which mark the proportions of brain." Dr. Turner, Professor of Anatomy in the University of Edinburgh, in a paper read before the Royal Society of that city, on Jan. 19, 1874, says, "The outer surface of the skull does not correspond in shape to the outside of the brain."

Now, sir, what is the meaning of all this? Out of mere curiosity I have consulted medical men with regard to the mutual relations of skull and brain, till I am tired, and, although they set out with the observation that the question is simply one of fact, no two of them give me the same answer. Indeed, they are completely at sixes and sevens. What I wish to point out as the moral of all this is, that for us there is nothing left but to fall back upon nature, which, as Dr. Gall said, is the only infallible testimony, and bring the inquiry to the test of observation and of fact, leaving medical men to dogmatise as they choose.

Glasgow, *Nov.* 25, 1881. A. B.

TECHNICAL TERMS—SCIENTIFIC NEWS—ILLUSION.

[115]—I take the liberty of sugggesting that you *request* corre spondents to place the technical terms they employ side by side with the popular modes of expression, for the reason given in letter 46, p. 78. In letter 46, p. 79, in the fourth line of the second paragraph, Mr. Allen, in alluding to the shape of the forehead, uses the term "orthomètopy," bracketing the meaning. So far so good, but only in the next line he makes use of the term "prognathism"; three lines further appears "orthognathism," and again five lines below the word "Sella." Writers must know that only specialists, or classical scholars, would understand the meaning of terms such as these. What, therefore, I take the liberty of suggesting would be your placing a standing notice to correspondents at the commencement of the correspondents' column. Also that, under the head of "Scientific News," you give weekly, or from time to time, the most recent inventions or discoveries in physical and mechanical science that would be of popular interest.

F. H. S.

In reference to the drawing I sent you last week illustrating an optical illusion (letter 65, p. 95), the effect is much more striking with the horizontal line uppermost.

[It seems to us more striking still when the angle is put uppermost or lowest.—ED.]

THE DURATION OF A FLASH OF LIGHTNING.

[116]—Can you or any of your readers give me information on the following two points:—

1. Did Wheatstone or anyone else ever make an experiment on a flash of lightning to determine the time of its duration?

2. If so, what was the nature of the experiment, and where is it described?

I may state, to prevent misapprehension, that I am quite aware that Wheatstone made experiments to determine the duration of an electric spark produced under certain definite conditions, and that these experiments are fully described in the "Transactions of the Royal Society." But I find it explicitly stated by several writers of high authority—for example, Mascart,* Daguin,† Ganot,‡—that Wheatstone made experiments on the lightning flash itself. They say he employed a white disc with black rays, very close together, which he put in rapid rotation, and so placed that it was illumiuated by each succeeding flash of lightning. The details of the experiment are fully given by Deschamel,§ who, however, does not ascribe it to Wheatstone. Now I have searched in vain for the authentic record of this experiment, and I should feel greatly obliged to anyone who can give me information about it in the pages of KNOWLEDGE.

I think you will agree with me that the subject is not without interest for your readers, when I mention the widely different statements that have been put before the public, quite recently, regarding the duration of a flash of lightning. According to Mascart,* it is less than $\frac{1}{1,000}$ of a second; according to Deschanel, † it is less than the $\frac{1}{10,000}$; and according to Tyndall,‡ less than $\frac{1}{100,000}$. "Wheatstone has shown that it certainly lasts less than a millionth part of a second."§ Of course, if this last statement be true all the others are, in a certain sense, true also; but they do not give us the whole truth.—Yours, &c. GERALD MOLLOY.

Catholic University of Ireland, 86, Stephen's-green, Dublin, *Dec.* 2, 1881.

**Electricité Statique*, ii., 561. †*Traité de Physique*, iii., 213.

‡ "Treatise on Physics," translated by Atkinson. Sixth Edition, p. 828.

§ "Natural Philosophy," translated by Everett. Sixth Edition. p. 641.

LUMINOUS PHENOMENON.

[117]—I find in the volume of the *Leisure Hour* for 1853, under the title of "Astral Wonders," a pamphlet on a lecture delivered by the Rev. J. Craig, M.A., a short time before.

I wish to call your attention to the following. He says:—"When I was a boy, from some cause or other I was put into a dark room and tried to escape out of it. I had a knife in my pocket, and I began to cut a hole in the door to try to get quietly away by coming at the latch. Still, something occurred which induced me to remain where I was. I heard a footstep, and I knew I was not doing quite right. When I pulled my hand back the sun happened to be shining very much and I saw little globules running off in all directions. I thought even then this was very remarkable. I again put out my hand, and on pulling it back I saw the little globules running off as before. When I grew up to be a man I began to think of that childish thing. I felt certain then that light was a fluid and could run off our fingers like water; and if you feel any interest in light and will examine for yourselves you will see that light is truly a fluid; it has its waves, its currents, its ocean deeps, and our telescopes may yet tell us something of its tidal surroundings."

I shall be most happy to receive any information on the above subject, viz. (that of light being a fluid) which you or any of your correspondents may afford me.—Yours faithfully, W. M. M.

[Mr. Craig seems to have mistaken a physiological for a physical phenomenon. His experience showed, as many others do, that "seeing is not always believing." In a railway accident I have seen "astral wonders," as I have when I have been pitched on to my head by a galloping horse, but I do not infer that stars reside in my head.—ED.]

A £5 TELESCOPE.

[118]—"Twenty" (letter 48, p. 79) cannot obtain an absolutely perfect instrument for £5, but for this sum he can obtain from numerous opticians a telescope which has all that is necessary for a beginner, and the other apparatus he can get from time to time (and at no considerable cost), as he becomes more experienced. The £5 telescopes advertised are refractors; that is, the usual sort with a lens (object glass, of 3 in. diameter) at the end of a tube. The other sort, termed reflectors, having a silvered mirror at the bottom of a tube reflecting the image to a focus at the top, are less costly (if a large instrument is wanted), but require very nice management, and should only be purchased after considerable experience is acquired. The £5 glasses are very good ones indeed, containing all the groundwork of a first-class instrument, and will be found all that "Twenty" wants to commence with. After a time, he will like a tall wooden tripod-stand (which can be made by a handy man), and will want to add a "finder;" that is, a miniature telescope fixed at the side, by looking through which a celestial object can be immediately brought into the field of view of the larger one. He will also want a couple of extra eyepieces of different powers to the one supplied with the instrument, as different objects require different powers to show them at their best. After this (if his taste for observation developes), he may like to replace the object glass with one by a celebrated maker. These things, however, only result from an increased passion for the study of the heavenly bodies. The instrument, as supplied for £5, contains all that is necessary for a beginner, and one who simply wishes to observe the stars for occasional pleasure will never want anything more. Such accessories

* *Electricité Statique*, ii., 561. † *Traité de Physique*, iii., 642.

‡ *Fragments of Science*, fifth edition, p. 311.

§ Lecture delivered in the City Hall, Glasgow, published in Nature, Vol. xxii., p. 341.

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as the *student* wants can always be added, and the cheap instrument made as complete as the most expensive. It is a great mistake for a beginner to have too large and complex an instrument, and the difference in view through a very large glass compared with an ordinary one, such as is here referred to, is not so great as would be imagined. I may add, that the eye can be educated the same as the hand, and, after a time, "Twenty" will be able to see much more through his glass than when he started. A novice looking at Jupiter, for instance, will see but a small blank disc, but a practised observer, looking through the same telescope, will see a multitude of interesting details on the planet's surface quite invisible to the former. It is scarcely necessary to add to the foregoing that for £5 a very good second hand instrument can sometimes be got by advertising. There is no occasion, either, to reply to "Twenty's" other telescopic queries, as I see the Editor promises an article upon the subject. Albert P. Holden.

107, Hoxton-street, N.

COMETS' TAILS.—RAINFALL AND FORESTS.—THE OLFACTORY TRACT.—INTELLIGENCE IN ANIMALS.

[119]—1. There is a question I should like to ask you with respect to comets' tails, viz.: Has the spectrum of the tail ever been obtained; if there has been one taken, was there any alteration or new band observed in the spectra? I look forward eagerly to the continuation of your articles on the subject, for, I am sorry to say, I am very ignorant on the subject.

2. With respect to your article on the Fiji Islands, I noticed the interesting circumstance of the rainfall diminishing simultaneously to the cutting down of timber. Was it not the same with the Island of Ascension, only in a still more remarkable degree; for had not the inhabitants to plant trees again, so that they might be again blessed with rain? I should be glad if you would inform me if I am correct in the above, for I do not know where to look to refresh my memory on the subject.

3. In reading "M. L.'s" article on "Vivisection," an idea occurred to me connected with the olfactory tract, on which I should like your opinion. It is this:—A good many years ago my cousin and self were working in the same "Lab.," and by accident he smashed a full Winchester of NH_4HO, with the natural result that he was half-suffocated; but the part I am curious about is, that from that day to this he has had neither taste nor smell. Do you think that the dose of NH_3 destroyed that part of the brain referred to by W. L.?

4. "Intelligence of Animals":—I am in a position to give rather a curious case of the intelligence of rats, proving—as does your article—the *practical*, but if we look at it in rather a favourable light, might prove even the abstract, which is wanting.

The rats in this case also "bored" through a lead pipe; so far there is no difference to the example in your paper, and you will think this is one of the "two and two equal four letters"; but this lead pipe, unfortunately for my father, was in the "hold" of one of his ships, and through their (the rats) craving for fresh water, and getting it, a great deal of damage was done; they actually did hit on the *fresh water* lead pipes in *preference* (may I say) to the other salt water ones (leading from the W.C.'s on deck, I mean, which, as you are aware, are cleaned by salt water.) This, I think, is a curious coincidence, for might it not be turned by scientists either way, either to accident or to sagacity on the part of the rats?—Yours, &c., F. C. S.

MEN'S HEADS.

[120]—I have read carefully the letters on the size of human heads. I am inclined to think that our heads, as a nation, are smaller. The size of the head corresponds to that of the body, so that large heads mean large bodies. This is seen amongst navvies, agricultural labourers, and Irishmen from country places. Now-a-days machines do a great deal of our mechanical work, and our muscles getting less exercise, are not so large. Again, living in towns, and having little bodily exercise or hard work, means small bones and smaller frames altogether. The size of the head increases with that of the body, so exercise ought to be part of the system at our public schools, and then we get a sound brain in a healthy body. T. R. Allinson, L.R.C.P., &c.

[*Owing to the extraordinary pressure of correspondence, our article on "Comets" (illustrated with views of the destroyed comet of Biela) is deferred till next week. We must earnestly entreat our correspondents to be concise, and only to write when they have something really interesting and new to communicate.*]

Queries.

[67]—Rainbow.—I should very much like to know why it is that a rainbow is semicircular?—G. S. M.

[68]—Solar Storms.—By what method is the velocity of wind, &c., in the sun ascertained?—G. S. M.

[69]—The Moon's Influence.—It has been stated by Dr. Ball that the result of the moon's action on the tides is to drive the moon further and further away, and that the consequence of this is that the day is getting longer and longer. He says that 50,000,000 years ago the moon must have been very close to the earth, at which time the day would be only three hours long. Will you kindly say if what Dr. Ball says is correct? and how the action of the tides drives the moon further and further away, and how the distance of the moon regulates the length of the day?—E. K. [Will shortly make the question the subject of an article. Dr. Ball' general conclusions are sound; the detailed results he would not, of course, regard as exact.—Ed.]

[70]—Seismometer.—A description of an approved form of seismometer would be much valued by M. A. F.

[71]—Names of Flowers.—Can you let me know, by means of your valuable paper, of any botany which will give the Latin and English names to all flowers, &c., and thereby much oblige.—R. D.]

[72]—Antiquity of the Pyramids.—"Sir John Lubbock, speaking of the antiquity of man, in his address at the late meeting of the British Association, said that 'The researches in Egypt seem to have satisfactorily established the fact that the pyramids themselves are at least 6,000 years old,' and mentions Professor Rawlinson's researches in support of this." What is the evidence on which this alleged antiquity is based?—Actinolite.

[73]—Clouds.—Is there any explanation of the peculiar forms of Cirri and other clouds, especially that known as a mackerel sky? If a large, flat vessel of water containing a little sediment is agitated slightly, the sediment is deposited on the bottom in forms resembling those of some clouds. Are the latter supposed to be formed in a similar way?—E. C. R.

[74]—Experiment on Solar Heat.—I have read somewhere that if one side be removed from a box (the interior of which is blackened), and in its place three panes of glass with spaces between them containing air are inserted, water placed in a vessel in it may be raised to boiling-point by the exposure of the box in its modified form to strong sunshine. How is it that the heat, when in company with the sun's light, can penetrate the successive layers of glass and air, yet when deprived of its luminous companion, is retained in the heat-trap?—E. C. R.

[75]—The Radiometer.—Would it be asking too much of our Editor to request that a series of papers explaining and describing the little that is known as yet of the forces and phenomena connected with the high vacua and radiometers might be given before long in the very interesting pages of Knowledge?—E. C. R.

[76]—Planetary Movements.—The earth moves round the sun because of the latter's attraction, *i.e.*, but for the sun's attraction, the earth would move forward in a straight line. The attractive force of the sun must, therefore, necessarily retard the forward motion of the earth. Is not this so? If yes, does the earth go more and more slowly round the sun, and will it not ultimately stop and be drawn into the sun, and when? If no, what is the force which causes the earth not to go more and more slowly?—E. F. B. Harston. [The answer to first question is "no"; and that, therefore, no force is required to prevent the earth from being retarded. Why should a force at right angles to her course retard the earth? Her path not being absolutely circular, the force of the sun sometimes slightly hastens and at others as slightly retards the earth; but in the whole year changes not her speed at all.—Ed.]

[77]—Terrible Dreams.—What explanation can be given of the horrible dreams that sometimes occur to persons?—S. S. S. S.

[78]—Antipathy and Sympathy.—What is the explanation of the extraordinary antipathy felt by some persons against some tame animals and things; and the converse—extreme sympathy, almost amounting to infatuation, shown by other persons (innate, not acquired)?—S. S. S. S.

[79]—Mental Physiology.—Whose works are now the best authorities on the study of mental physiology?—S. S. S. S.

[80]—The Chin.—It has been said that man is the only animal having a chin. Long before recent attention was called to the deficiency of this feature in a certain homicidal criminal, observation had led me to note various cases of cruelty perpetrated by almost chinless people; once, indeed, by a very young creature of twelve years old, described truly, I think, as "a perfect brute." Where

cruelty has not been observed, gluttony has been the marked failing. I have seen a chinless man eat like a pig, and look exactly like a pig while eating. Does not the paucity of this characteristically-human feature point to the animal propensities being in excess of the moral, if not the intellectual, tendencies? The Papuans are said to have little chin, and to be very cruel. ETHNOLOGIST.

[81]—THE MOON'S ATMOSPHERE.—By whom and when was the discovery made that there is no atmosphere around the moon? Swedenborg claims the honour of having the fact communicated to him by angels, and that he was the first to know and publish it.

[82]—PROBABILITIES.—Has not the writer of the article on "Trusting to Luck" put "eight times running" and "nine times running" where he should have written "nine times running" and "ten times running" respectively, the chances being

$$\frac{1}{2^9} \text{ and } \frac{1}{2^{10}} \text{ equal to } \frac{1}{512} \text{ and } \frac{1}{1024}$$

respectively?—H. A. N.—[Yes.—ED.]

[83]—CHEMICAL QUERIES.—(*a*) Are there more than three allotropic modifications of sulphur? The two crystalline forms and the plastic modification I am acquainted with, but in Miller's "Inorganic Chemistry" ("Longman's Text-Books"), 1874, it is stated that "a fourth may be procured by placing in carbon disulphide the hard mass furnished by keeping the viscous sulphur till it becomes solid. The carbon disulphide discloses all that can be removed from the mass, and a *grey amorphous powder* is left" (p. 142). Roscoe, in his "Elementary Chemistry," simply says that "the tenacious" (*i.e.*, viscous) "form is insoluble in" carbon disulphide. Does the latter refer to the amorphous powder mentioned by Miller? (*b*) In Roscoe's "Elementary Chemistry," p. 62, edit. 1880, referring to nitrogen tetroxide, I find it stated that "this substance forms the greater part of the reddish brown fumes evolved when *nitrous* oxide gas escapes into the air." Should this not not be *nitric*? (I may say that at present I have not an opportunity of trying these for myself.)—THEION.

[84]—ANCIENT MAN.—In Darwin's "Origin of Species," I read, "Mr. Horner's researches have rendered it in some degree probable that man sufficiently civilised to have manufactured pottery existed in the valley of the Nile thirteen or fourteen thousand years ago." I should like some information about these researches, and their reliability.—CLIO.

[85]—A GRAVITY ILLUSION.—The Toricelli tube, or a long glass tube filled with mercury, and turned upside down, when full, into a cup of mercury again, is said by some acquaintance of mine to be unexplained, in so far that in theory, he says, the mercury glass-tube, when lifted up, should not weigh more than the weight of the glass, considering that the mercury is carried by the cup on the table in which it is. But, instead of this, it is found to weigh very much more. I was not many minutes in solving the mystery to myself, but do not yet know if it is really a mystery to professors of physics, as my acquaintance maintains. I can hardly think so, as I fancy to have read the law that gives the cause. However, I will give my version of it, after some one of your readers answers.—F. J. D. "SELBST." [There is no mystery in the matter, but the study of this question, as of others in our Query columns, may be a useful exercise to beginners in physics.—ED.]

[86]—THE COLOUR OF BIRDS' EGGS.—Are the different markings on birds' eggs considered to be merely accidental, or designed for special purposes?—ARACHNIDA.

[87]—TOADS.—What is the internal construction of the common toad, which permits of its existing for many years enclosed in blocks of solid matter?—ARACHNIDA.

[88]—BRAIN INJURIES.—How is it the brain can be cut and cauterised without exciting sensation? If true, this contradicts, apparently, the statement that the brain is the organ of feeling, made in W. L.'s letter (29, No. 3). Is electricity necessary to convey the least feeling or irritation to the brain?—BEE.

[89]—GELATINE PLATES.—I have just now a few gelatine plates, in which a red streak appears, either on the top or at the bottom, and seems to eat its way through the film, and so spoils them; also the silver from the paper coming on to the plate. A remedy for the above would oblige. Have any photographic readers of KNOWLEDGE tried to develope their gelatine plates by flowing over them a weak solution of silver, and developing afterwards the same as a wet plate? If so, kindly give me their experiences.—PERSEVERE.

[90]—THE MAGNETIC NEEDLE.—I should be glad if any reader can give me any information why the needle of the compass always points to the north, what is the attraction, &c.—W. H. PERTWEE.

[91]—MISSING LINK.—KNOWLEDGE for Nov. 25, p. 74, has an article, "The Missing Link," in which it refers to an article that has appeared on the same subject in a recent volume of the *Gentleman's Magazine*. Please say name of month in which this appeared.—TEASULANT.

Replies to Queries.

[4]—THE EARTH'S INCLINATION.—The motion of the earth is best shown by suspending a small globe by a piece of string, and carrying it round a candle (the candle being in the centre of its path). If the globe is carried on a level with the candle, it is seen that the poles will both just see the candle, *i.e.*, the poles and the whole earth will have perpetual spring. The true motion will be obtained by making the circular path *dip* half below and half above the level of the candle as it is carried round, so that at the lowest part the whole of the North Arctic zone may be in light, and at its highest point in shadow.—H. A. N.

[8]—VOLUME OF SPHERE.—Given that area of sphere = area o 4 great circles = $4\pi r^2$. Let the sphere be divided into pyramids, with the apex at the centre. If the number of pyramids is great, the base of each is nearly plane, and the pyramid

$$= \frac{1}{3} \times \text{height} \times \text{base}$$
$$= \frac{1}{3} \times r \times \text{base}.$$

The whole sphere is one of these pyramids multiplied by the number of times the area of the sphere contains the base, *i.e.*,

$$\frac{1}{3} r(\text{base}) \times \frac{4\pi r^2}{\text{base}} = \frac{4}{3}\pi r^3$$
$$= \frac{2}{3} \text{ of cylinder.}$$

This implies, however, the knowledge that the area = four great circles, which cannot be proved without the calculus.—H. A. N.

[10]—THE ZOETROPE.—The impression of any sight remains on the retina for the seventh part of a second; if a new impression is received before the first has faded, the two are seen simultaneously, and if the Zoetrope is turned too quickly, the images run into one another. If it is turned so that one-seventh of a second intervenes between two impressions, the motion will appear continuous; if it moves slower than this, it will seem jerky.—H. A. N.

[14]—VELOCITY OF SOUND.—"Sound's" difficulty arises, I think, from his not considering that the air is sensibly devoid of absorption and radiation, so that the heat generated in the condensation remains there to augment the velocity—or, rather, the elasticity upon which the velocity depends. In the rarefaction, the elasticity is lowered, both by the separation of the particles and the cold developed by such separation; and consequently "the cold developed augments the difference of elastic force upon which the propagation of the rarefaction depends." It is because the heat generated in the condensation augments the rapidity of the condensation, and the cold developed augments the rapidity of the rarefaction, that the heat and cold both help to augment the velocity of the sound wave. In gases possessing considerable absorptive and radiative power, "Sound's" objection would be perfectly valid.—T. J. H.

[16]—GERMAN AND ENGLISH.—In reply to "Eclecticus," Messrs. Macmillan & Co. publish a work which I think would suit him, entitled "A Comparative Grammar of the Teutonic Languages." By G. Helfenstein. Its price, I believe, is 18s.—W. G. ROLFE.

[18]—CHEMICAL TREATISES.—I have before me the ninth edition of "Fownes' Chemistry," on the old or equivalent notation, with an appendix epitome of the new system. Then I have Hoffmans' work on "Modern Chemistry;" also the little volume by Wurtz, "Chemical Philosophy according to Modern Theories," translated by Crookes; also "The New Chemistry," by Cooke (International Series); and, lastly, "Pilden's Chemical Philosophy." I would especially award the prize to the little work of Wurtz, which is exceedingly good and clever; but many years' study convinces me that "Modern Chemistry" is wholly based on very slender hypotheses, and that the consequent complexity and confusion must necessitate a change. An independent inquirer has little chance in England, but in France the Chemical Hierarchy is untainted with inconsiderate revolution; and M. Berthelot must be considered one of the greatest chemists of the age. If old or equivalent chemistry means *knowledge*, and new chemistry means hypothesis, it is especially *à propos* for this Paper to ventilate and make clear the difference.—ECLECTICUS.

[19]—COMPARATIVE ANATOMY OF BIRDS AND MAMMALS.—The furcula of birds are formed by the union of two bones called the clavicles. These are almost entirely absent in mammals. When present they are very rudimentary, and usually unossified; so that no trace of them is found in the dried skeleton. In man, the clavicles are more developed than in the other mammals, and constitute the so-called collar-bones. They are very rudimentary in dogs and rabbits. In the felidæ (lions, tigers, cats, &c.) they are more developed than in other carnivora, but have no particular

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function. They are entirely absent in the ungulata. Clavicles are very characteristic of the lower vertebrata, being well developed in reptiles and fishes.—Geo.

[19]—Comparative Anatomy of Birds and Animals.—In answer to Query 19 p. 80, the furculum, or "merry-thought," of birds corresponds to the collar-bones, or clavicles, in man, which, instead of being separately joined to the sternum, or breast-bone, are joined together into a V-shaped arch of bone, the apex of which is commonly attached to the sternum by a ligament. The function of the furculum, according to Owen, is to oppose the force which tends to press the humeri or upper-wing bones towards the middle line during the downward stroke of the wing.—Medicus.

[23]—Faure's Accumulator.—"Nameless" will find some information in regard to Faure's accumulator in *Nature*, vol. 24, p. 68, "Storing Electricity;" and p. 238 "Faure's Secondary Battery."—A. T. C.

[23]—Faure Accumulator.—A Faure accumulator may be made as follows:—Take lead foil such as used for putting on damp walls; cut the plates, leaving a long tongue at one corner—I made the plates $4\frac{1}{4} \times 2\frac{1}{4}$ inches, with a tongue 2 inches long and about $\frac{3}{4}$ of an inch wide; next take some flannel—I used common, at 10d. a yard; cut it in strips one inch more in length than twice the length of the lead plates, and one inch wider than those plates; then take some blotting-paper and cut it into pieces, one inch each way larger than the lead plates; mix one pint of sulphuric acid, by measure, with ten pints of water, by measure, and with this and some red lead, make a paste; now, paint over one strip of flannel, on one side only, with the paste, leaving a half-inch margin of clean flannel all round, so that the painted part of the flannel will be exactly twice the size of the lead plate; paint over one of the lead plates on both sides, keeping the tongue clean; lay it on the painted flannel, and double the flannel over it; lay this covered plate down on any convenient board or piece of glass. On this covered plate lay one of the pieces of blotting-paper, or, if the blotting-paper is not thick and good, two pieces. Prepare another plate of lead with the flannel and red lead, as before; place this on the top of the blotting-paper, taking care that the tongue of this latter plate is on the opposite side to the tongue of the first plate. Lay another piece or pieces of blotting-paper, and so go on until you have a pile of as many plates as will go easily into the jar or cell you intend to use. See that the tongues of the alternate plates are on alternate sides of the pile of plates, then tie the pile round loosely in a couple of places with some paraffined twine; pinch the tongues on one side together, and those on the other side together, and attach terminal wires. Put the bundle of plates into the cell, fill up with the acid and water, and keep it full. I have tried this plan, and found it answer.—H. B. T. Strangeways.

[26]—Training.—There are some facts, if one could collect them, which seem to support "Oarsman's" question. Thus I know of two or three bicycle riders who ride a hundred miles a day, and yet who never taste animal food; and, again, a teacher of swimming who uses no animal food. The last few autumns a number of gentlemen have set out for walking tours, and they never use animal food, and yet get on very well indeed, saying they experience less thirst and less fatigue than if they eat meat, &c.—T. R. Allinson.

[27]—Marriage Death-rate.—With reference to "Benedict's" query respecting the marriage death-rate, I may say, for his information, that the result of an estimation made, showed that a number of married persons gave a mean death-rate of 66·76; and of unmarried a mean of 62·00.* I may also state that at the age of 15 to 20 the mortality is increased considerably, especially among women—the majority of deaths resulting from consumption and childbirth. A greater proportional number of deaths occur among those who marry at an early age.—Michael W. Reynolds. [Rest of letter not strictly *ad rem*.—Ed.]

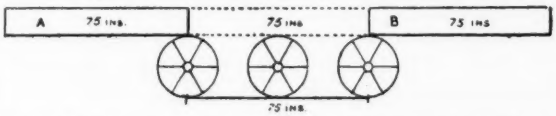
[27]—Marriage and the Death-rate.—I refer "Benedict" to the following extract from the *Times* (Weekly Edition), Febuary 14, 1879:—

"It has been shown from statistics that in general, married people have a less mortality than the unmarried or widowed. Among facts indicating the relation between marriage and physical health, it has been proved by M. Janssens, of Brussels, that at all ages widowers are about twice as liable to phthisis as other men, but that married people are generally more liable to this disease than celibates. This law is constant for women; for men it holds good only before 25 years of age and after 45. Such facts and their meaning are discussed by M. Bertillon in a recent paper on the influence of the family state on morals. Not only do married people die less than others, but they show less tendency to suicide, to mental derangement, to assassination, to theft, and other like evils or crimes. . . ."

And the extract goes on to shew that this is probably owing to the influence of children.—B. J.

[27]—Effects of Marriage on the Death-rate.—Dr. Bertillon, a French *savant*, some two or three years ago wrote an essay on "Nuptiality, or the Conjunctive Attraction of Human Couples." By comparing the mortality statistics of every country in Europe, he shows that, without exception, marriage is conducive to longevity. He arrives at the conclusion that a bachelor of 25 is not a better life than a married man of 45. French bills of mortality show that the annual death-rate among married men between 20 and 25 is rather under 10 per 1,000, and for bachelors of the same age, 16 per 1,000. For Paris itself the difference is still greater. Between 30 and 35 years of age the mortality is 69 per cent. greater among bachelors than among married men. Space will not permit further quotations from this interesting essay, but a more complete summary of Dr. Bertillon's conclusions "Benedict" may find in the *Lancet* for May 31, 1879.—Medicus.

[28]—Stone on Rolling Wheels.—If the stone was poised exactly in the *centre* of the wheels, it would then be carried forward 75 in. for each revolution, and the relative position of the stone and wheels is not altered. But, as the stone rests on the circumference of the wheels, it receives a motion from the revolution, and the part which rested on the wheels would be 75 in. beyond them for each revolution; and the forward motion of the wheel being 75 in., therefore the stone has advanced 150 in. It has travelled the same distance as a spot on the circumference of the wheels, which describes a cycloid for each revolution, and is equal in length to



double the circumference. I beg to inclose drawing, where A is commencement of a revolution, and B the end.—W. Stevens.

[28]—Stone on Rolling Wheels.—"Queensland's" "mathematical friend" is quite correct in saying the stone advances 150 in. for every 75 in. advance of the rollers. "Queensland," or any one else, may easily convince himself of the accuracy of the statement by a few minutes' experimenting with a two-foot-rule and an office ruler.—E. H. R.

[37]—"Vestiges of Creation."—I have seen it stated that the late Dr. David Page, the geologist, was the author of this book. It has also been attributed to Mr. Robert Chambers. Both may have been concerned in it, as Dr. Page was for a long time connected with *Chambers's Journal*. I think Lieut.-Col. W. A. Ross announced in the columns of the *English Mechanic*, some time ago, that he believed, and could prove, the author to be Sir Charles Lyell.—J. A. Westwood Oliver.

[37]—Vestiges of Creation.—This book was written by the late Dr. Robert Chambers, of Edinburgh. It foreshadowed, in some measure, the speculations of Darwin on the origin of new species through the modification of the old, as opposed to the doctrine of their "special creation." It advanced further than Lamarck; but Dr. Chambers' ideas were necessarily crude, for lack of the knowledge of later days, when compared with the certainties of modern evolution, which is founded on evidence derived from the development, structure, and distribution of animals and plants, as well as from their fossil history. "S. S. S. S." should read Darwin in preference to the "Vestiges," which possess, nowadays, more of a historical than a scientific interest.—Andrew Wilson.

[37] — Vestiges of Creation. — This work was published anonymously. Some—the majority—attribute it to Chambers, others to Sir C. Lyell. The subject was discussed recently in the columns of the *English Mechanic*. I should advise "S. S. S. S." to read it by all means, and mark, learn, and inwardly digest it.—W. G. Rolfe.

[38]—Neptune.—One satellite of Neptune has been discovered by Lassell, period 5 d. 21 h. 8 m., at a distance of 220,000 m. from the primary.—W. G. Rolfe.

[Let. 48]—Cheap Microscope and Telescope.—If your correspondent "Twenty" is not disposed to spend more than £5 on *each* of the above, he must restrict himself to a monocular microscope, and I should advise him to procure one of the so-called medical forms made by Swift, Beck, Baker, and several others. It is rather invidious making a selection from the several makers of low-priced microscopes, but I am bound to say that of the instruments which have come under my notice lately, Swift's are the best value for the money, taking into account the appearance and general qualities of

* There is some mistake about this statement.—Ed.

the stand and the quality of the lenses supplied. This is very much like an advertisement; but you, sir, may possibly know enough of me to tell you that I am not an advertising agent. Anyhow, wherever the instrument is purchased, let "Twenty" see to it that he is not misled by mere appearance. Get a solid stand—one that won't shake and twist about; and don't trouble about a lot of so-called accessory apparatus. You won't want it. Then see that you have a good inch and a good quarter-inch objective. You can do plenty of work with them; enough to make yourself a name in the world, and get plenty of recreation too. I am the possessor of a £5 telescope bought to let my bairns see the mountains in the moon, spots on the sun, and something of Jupiter, Saturn, &c.; but shall I say it, sir, and so shake your faith in my powers of replying to the query, that is all the "astronomy" I have done with it. What it does show it shows well, and enough for my purpose. That is all I can say.—H. P. H.

[48]—Trisection of Triangle.—There are three problems now given up as beyond the power of Geometry, namely, (i) to trisect any angle, (ii) to find a straight line equal to the circumference of a circle, and (iii) to find two mean proportionals between two given straight lines. Thus, "Euclid" is beyond the range of help.—W. G. Rolfe.

[54]—Chemical Questions.—The explanation of (1) is that the iron of the ferrocyanide is not a base, but forms part of an acid, which, however, has never been isolated. Potassium ferricyanide acts in a similar way. A parallel case is chromate of potassium, or any metal which will not precipitate, as hydrate, unless reduced by zinc, or tin and acid. (2) To this part of "Castor and Pollux's" query, I cannot see an answer, unless the solution were alkaline; alkalies dissolving potassium tartrate.—C. T. B.

[54]—Chemical Questions.—In the first case given by "Castor and Pollux," the reason he has obtained no precipitate with ferrocyanide of potassium on adding the re-agents mentioned is this, that he has been inattentive, I might even say careless, enough to add hydrosulphuric acid instead of ammonium sulphide. He very correctly states that iron is one of the third group of metals, but the metals of that group are precipitated by Am Cl, Am HO and Am HS, and not by H_2S. And in the second case it is quite possible that the solution of tartaric acid was not sufficiently strong, although the salts under examination may have been so. This test is extremely delicate, and requires much more care than the questions of "Castor and Pollux" lead me to believe he has taken in his analysis.—Theophilus Pitt, A.K.C.

[55]—Greek Verbs.—Lengthening the vowel is the rule, deviation from it the exception. Those verbs which retain the short vowel take σ in pf. and ppf., med., or pass.; also in their verbal adjectives.—W. G. Rolfe.

[59]—Mercury's Revolution.—Undoubtedly 84 was a misprint; it should have been 88.—W. G. Rolfe.

[60]—Sound being the effect produced on the ear by any vibration, within limits of fastness and slowness, any substance that will vibrate can transmit it. Tyndall compares transmission of sound to a blow passed along a number of balls touching side by side; the last of the row only moves, so the last vibrated particle gives the sound, and can pass it on from one substance to another. The greater the elasticity—as steel, glass, ivory—and the lighter in weight, the better does a body transmit sound.—C. T. B.

[66]—Venus.—This planet is frequently visible in the day-time, and often casts a shadow at night.—W. G. Rolfe.

[66]—Venus by Daylight.—Taking the above query of F. H. S. to refer mainly to the planet's visibility *in England*, I may tell him that, owing to the unfavourable atmospheric condition that generally obtain here, she probably is not often visible during the daytime, although I saw her plainly several times this summer, on different days in (I expect) the month of July, when she had a considerable north declination, and was at her extreme westerly elongation from the sun (or thereabouts). I should mention that by visibility I mean visibility to the *naked eye*. If F. H. S. has sufficient knowledge of astronomy to understand the meaning of the terms "right ascension" and "declination," he will know how to find the position of Venus in the sky at any time by her bearing from the sun. Abroad, within and without the tropics, I have seen Venus day after day, for weeks at a stretch, and at sea have often determined the latitude daily for like periods, both in the mornings from about 9 to 10, and in the afternoons from 2 to 3, according as she was, respectively, to the west or to the east of the sun. In many of these cases, however, she would not be visible to the naked eye. If your correspondent has not that slight skill in astronomy with which I have credited him, I am afraid you would hardly allow me space to explain to him how and when to "spot" Venus.—Winter.

INFLUENCE OF MARRIAGE ON THE DEATH-RATE.

[Note.—The enclosed is an answer to the query of "Benedict" upon the effects of marriage on the death-rate, if you should consider it worthy of insertion.—W. H. Pertwee.]*

For several years it has been noticed by statisticians that the death-rate of unmarried men is considerably higher than the death-rate of married men and widowers. I believe that Dr. Stark, Registrar-General for Scotland, was one of the first to call attention to this peculiarity, as evidenced by the results of two years' returns for Scotland.

But the law has since been confirmed by a far wider range of statistical inquiry. The relative proportion between the death-rates of the married and of the unmarried is not absolutely uniform in different countries, but it is fairly enough represented by the following table, which exhibits the mortality per thousand of married and unmarried men in Scotland:—

Ages.	Husbands and Widowers.	Unmarried.
20 to 25	6·26	12·31
25 „ 30	8·23	14·94
30 „ 35	8·65	15·94
35 „ 40	11·67	16·02
40 „ 45	14·07	18·35
45 „ 50	17·04	21·18
50 „ 55	19·54	26·34
55 „ 60	26·14	28·54
60 „ 65	35·63	44·54
65 „ 70	52·93	60·21
70 „ 75	81·56	102·71
75 „ 80	117·85	143·94
80 „ 85	173·88	195·40

From this table we are to understand that out of one hundred thousand married persons (including widowers), from 20 to 25 years old, 626 die in the course of each year; while, out of a similar number of unmarried persons between the same ages, no less than 1,231 die in each year. And in like manner all the other lines of the table are to be interpreted. Commenting on the evidence supplied by the above figures, Dr. Stark stated that "bachelorhood is more destructive to life than the most unwholesome trades, or than residence in an unwholesome house or district where there has never been the most distant attempt at sanitary improvement of any kind." And this view has been very generally accepted, not only by the public, but by professed statisticians; yet, as a matter of fact, I believe that no such inferences can legitimately be drawn from the above table. If death strikes down in five years only half as many of those who are unmarried between the age of 20 and 25 (as appears from the above table), and if the proportion of deaths between the two classes goes on continually diminishing in each successive lustre (as is also shown by the above table), it seems reasonable to infer that the death-rate would be even more strikingly disproportionate for persons between the ages of fifteen and twenty than for persons between the ages of twenty and twenty-five. I believe, indeed, that if Dr. Stark had extended his table to include the former ages, the result would have been such as I have indicated. Yet few will suppose that very youthful marriages can exercise so singularly beneficial an effect. It may appear at first sight that we are bound to accept the conclusion that matrimony is favourable to longevity. In the present instance we have simply to deal with the fact that the death-rate of unmarried men is higher than the death-rate of married men and widowers. All that we can can do is to show that one of three conclusions must be adopted. Either matrimony is favourable (directly or indirectly) to longevity, in a degree sufficient wholly to account for the observed peculiarity, on a principle of selection—the effect of which is such as, on the whole, to fill the ranks of married men from among the healthier and stronger portion of the community—operates in a sufficient degree to account wholly for the observed death-rates; or, lastly, the observed death-rates are due to the combination, in some unknown proportion, of the two causes just mentioned. No reasonable doubt can exist, as it seems to us, that the third is the true conclusion to be drawn from the evidence supplied by the mortality bills. Unfortunately, the conclusion thus deduced is almost valueless, because we are left wholly in doubt as to the proportion which subsists between the effects to be ascribed to the two causes thus shown to be in operation. It scarcely required the

* As I considered this article worth sending to the *Daily News*, I suppose I may accept Mr. Pertwee's suggestion. Passages from the article are quoted by Darwin, in his "Descent of Man," and his approval led me to include the article in my "Light Science for Leisure Hours." Mr. Pertwee's quoting from the original suggests that the matter may be new to many of our readers.—R. A. Proctor.

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evidence of statistics to prove that each cause must operate to some extent. It is perfectly obvious, on the one hand, that although hundreds of men who would be held by insurance companies to be "bad lives" may contract marriage, yet, on the whole, a principle of selection is in operation which must tend to bring the healthier portion of the male community into the ranks of the married, and to leave the unhealthier in the state of bachelorhood. A little consideration will show, also, that, on the whole, the members of the less healthy trades, very poor persons, habitual drunkards, and others whose prospects of long life are unfavourable, must (on the average of a large number) be more likely to remain unmarried than those more favourably situated. Improvident marriages are undoubtedly numerous, but prosperity and adversity have their influence, and that influence not unimportant, on the marriage returns. On the other hand, it is perfectly obvious that the life of a married man is likely to be more favourable to longevity than that of a bachelor. The mere fact that a man has a wife and family depending upon him will suffice to render him more careful of his health, less ready to undertake dangerous employments, and so on; and there are other reasons which will occur to everyone for considering the life of a married man better (in the sense of the insurance companies) than that of a bachelor. In fact, while we are compelled to reject Dr. Stark's statement, "bachelorhood is more destructive to life than the most unwholesome trades, or than residence in an unwholesome house or district, where there has never been the most distant attempt at sanitary improvement of any kind," we may safely accept his opinion that statistics "prove the truth of one of the first natural laws revealed to man, "It is not good that man should live alone." Whether the law required any proof is a question into which we need not enter.

From the *Daily News*, *Oct.* 17, 1868. W. H. Pertwee.

Our Mathematical Column.

MATHEMATICAL QUERIES.

[2]—The Witch of Agnesi.—Will you kindly furnish a few particulars respecting the history, properties, and practical application (if any) of the above-named curve? If these are accompanied with a tracing of the curve all the better.—E. H. R.

[3]—Apparent Paradox.—

$$\begin{aligned}
&\text{Let} && x = y,\\
&\text{then} && x^2 = yx,\\
&\therefore && y^2 - y^2 = xy - y^2,\\
&\therefore && (x+y)(x-y) = y(x-y), && (A)\\
&\therefore && x + y = y, && (B)\\
&\therefore && y + y = y, \text{ since } x = y \text{ by Hyp.};\\
&\therefore && 2y = y\\
&\therefore && 2 = 1.
\end{aligned}$$

Anyone who kindly explains the fallacy in the reasoning which brings about this impossible result will much oblige—Puzzled.

[The fault lies in passing from A to B. Interpret them, and we see this at once. A really means that $(x + y)$ times nought is equal to y times nought, which is, of course, true; just as it is true that twenty times nothing is equal to ten times nothing. But we can no more infer that $x + y = y$ than that $20 = 10$. In fact, we cannot divide both sides of an equation by any common factor, unless we are sure that the factor is not equal to nought. In this case we know that it is.—Ed.]

[4]—I shall be very much obliged if you will kindly favour me with a solution of the following problem. Data. $R = 2$; $S = \sqrt{3}$; $r_b = 1$; r, r_a, r_b, r_c, being radii of inscribed and escribed circles: prove that $4rr_a = a^2$, and $r_b = r_c =$ perp. from angle A on side BC of inscribed triangle.—Amicus.

Our Whist Column.

By "Five of Clubs."

A "YARBOROUGH" HAND AT WHIST.

Sir,—I was told the other day that a former Earl of Yarborough was always ready to wager £1,000 to £1 against the occurrence of a hand at Whist in which there should be no card better than a nine. Was the bet a fair one? Aletheus.

[The bet was decidedly unfair, and if made a great number of times must have resulted in large gains to the person who made it. It is easy to calculate the odds before the deal, (after the deal, or if the cards are cut and the lowest card is known, the odds are slightly altered). In each suit there are five cards, ace, king, queen, knave, ten, above a nine, or in the pack, 20 cards above a nine. From the remaining 32 cards a hand of 13 cards may be formed in

$$\frac{32 \cdot 31 \cdot 30 \cdot 29 \ldots\ldots 20}{1 \cdot 2 \cdot 3 \cdot 4 \ldots\ldots 13}$$

different ways. The whole pack, however, will form

$$\frac{52 \cdot 51 \cdot 50 \cdot 49 \ldots\ldots 40}{1 \cdot 2 \cdot 3 \cdot 4 \ldots\ldots 13}$$

different hands of thirteen cards. The chance, then, that any hand taken at random will have no card better than nine is represented by the ratio which the former of these amounts bears to the latter, or by the fraction

$$\begin{aligned}
&\frac{32 \cdot 31 \cdot 30 \cdot 29 \ldots\ldots 20}{52 \cdot 51 \cdot 50 \cdot 49 \ldots\ldots 40}\\
&= \frac{32 \cdot 31 \cdot 30 \cdot 29 \cdot 28 \cdot 27}{51 \cdot 49 \cdot 47 \cdot 45 \cdot 43 \cdot 41 \cdot 2^7}\\
&= \frac{31 \cdot 15 \cdot 29 \cdot 14 \cdot 27}{51 \cdot 49 \cdot 47 \cdot 45 \cdot 43 \cdot 41} = \frac{31 \cdot 29 \cdot 2 \cdot 3}{17 \cdot 7 \cdot 47 \cdot 43 \cdot 41}
\end{aligned}$$

It will be found, on reducing, that this fraction is rather less than $\frac{1}{1828}$, so that Lord Yarborough, if he had been fair, (assuming always that he knew how to calculate probabilities) should have offered rather more than £1,828 to £1 against the occurrence of the hand in question. It must be understood, of course, that he wagered with one of the players against that player having a "Yarborough," not against the occurrence of a "Yarborough" among the four hands dealt. The chance of this latter event is, of course, considerably greater. It might seem at a first view that it was exactly four times as great, since there are four hands for each deal, but this is not the case, any more than the chance of the occurrence of a Yarborough in 1,828 hands amounts to 1,828 times $\frac{1}{1828}$, or to absolute certainty. The real chance that a Yarborough will not occur in four hands is thus obtained. The chance that a Yarborough will not occur in any given hand is $\frac{1827}{1828}$; that it will not occur in two hands is $\left(\frac{1827}{1828}\right)^2$ that it will not occur in three hands is $\left(\frac{1827}{1828}\right)^3$, and that it will not occur in four hands is $\left(\frac{1827}{1828}\right)^4$. This is very nearly, but not exactly, equal to $\frac{1828}{1832}$, or to $\frac{457}{458}$; so that the chance of a "Yarborough" occurring in any four hands, taken at random in different deals, is equal to about $\frac{1}{458}$; nor is the chance different when the four hands are in the same deal.

Supposing Lord Yarborough offered a wager of £1,000 to £1 to each member of a whist party, for ten deals, on each of 100 nights in each of ten years, he would have cleared about £18,000.]

"Mogul" writes to us that there are mistakes, some of them serious, in our Whist Column. It is very likely; but the principle on which this column, like the rest of Knowledge, is conducted, is that of free discussion, and the correction of errors as soon as detected and pointed out. "Mogul" only notes one, and there he misapprehends us entirely. He says we in effect say that the rules for leading are based on the principle of giving information to your partner. We have said nothing of the sort. We have said that the first great principle of the scientific game is to give your partner all the information in your power, consistently with the rules of the game. This is a very different thing. "Mogul" states rightly enough that the primary consideration in selecting what card to lead, especially what card to lead from any peculiar combination of cards in a suit, has been the best chance of trick-making. Of course, this is true; but, as an objection to our statement, "Mogul" might as reasonably have told us that the primary object in Whist was to make tricks. "Mogul" will find, as we proceed, that all questions of leading and play, second-hand or third-hand, are primarily weighed with reference to the chance of making tricks (which, by-the-way, has not yet been fully done, even the ablest Whist players being apt to shirk the mathematical problems involved). But that is not at all inconsistent with the statement respecting the distinction between scientific and unscientific Whist, or between what may be called the twenty-six card and the thirteen card games.

"Mogul" invites our attention to Hoyle and Cavendish. These, with Matthews (though Hoyle and Matthews are now a little out of date), Pole, Clay, Drayson, and others are our guides; to this degree, at any rate, that we should not depart from their teaching without assigning our reasons and speaking under correction from our readers. But vague corrections, like "Mogul's," are of little use to us.

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Our Chess Column.

Great pressure of other matter compels us to limit our chess this week to a single game. It is, however, annotated fully, as promised in Number 1.

GAME PLAYED AT LEAMINGTON MEETING, OCTOBER, 1881.

Queen's Fianchetto.

WHITE. Mr. Walton.	BLACK. Mr. Bowley.
1. P. to Q.Kt.3.	P. to K.4. (a)
2. B. to Kt. 2.	Q.Kt. to B.3.
3. P. to K.3.	P. to Q.4.
4. B. to Kt.5.	B. to Q.3.
5. Q. to K.2. (b)	B to K.3
6. P. to K.B.4.	P. to K.B.3.
7. P. takes P.	P. takes P.
8. P to B.4. (c)	Q. to R.5.(ch.)
9. P. Kt.3.	Q. to K.5.
10. Q. to B.3. (d)	Q. to B.7.
11. B. to B.3. (e)	K. to K.2. (f)
12. Kt. to K.2.	R. to K.B.
13. Q. to Kt.2.	Kt. to B.3.
14. Castles.	P. to K.R.4.
15. P. to Q.4.	Kt. to K.Kt.5.
16. P. to B.5. (g)	R. takes R.ch. (h)
17. Q. takes R.	R. to K.B.
18. P. takes B.(ch.)	P. takes P.
19. Q. to K.sq.	Q to K.5.
20. Kt. to Q.2. (i)	Q. takes P.(ch.)
Resigns (j)	

NOTES BY MEPHISTO.

(Incorporating Mr. Bowley's comments.)

(a) In reply to 1. P. to Q.Kt.3., it is not advisable to advance P. to K.4. and Q.4. too hastily. P. to K.3. and Q.4. brings about a normal and safe development.

(b) Loss of time: White might have played P. to K.B.4. at once if that was his intention; but this attack was premature. P. to K.R.4. would have been better than Q. to K.2., to prevent the check with the Queen on R.5. Proper play was to develop the game by 4.P. to Q.B.4, Kt. to Q.B 3., &c., after the fashion of Queen's openings.

(c) Having missed the flood tide of the opening, fortune turns against White. P. to B.4. here is weak, as it opens up his game, of which Black at once takes advantage. In view of the good position of the Black Bishops, it would have been dangerous to castle on the King's side. 8. Kt. to Q.B.3. might have been played. Mr. Bowley points out that Black could not venture on

8. $\frac{\text{B. takes Kt.ch,}}{\text{P. takes B.}}$ followed by 9. B. takes P., because of

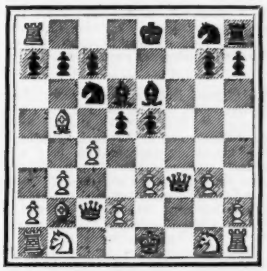
9. Q. to R.5. (ch.) 10. $\frac{\text{P. to K.Kt.3.}}{\text{Q. to K.5.}}$ winning.

(d) 10. Kt. to K.B.3. would have been better. If then Black played 10. Q. to B.7. 11. P. to Q.3. would have equalised the game; or, if B to Kt.5., in reply to 10. Kt. to K.B.3., then 11. Castles with a safer game than that obtained through the move in the text.

(e) Mr. Bowley thinks that 11. $\frac{\text{P. takes P.}}{\text{B. takes P.}}$ 12. $\frac{\text{Q. takes B.}}{\text{Kt. to K.2.}}$ 13. $\frac{\text{Q. to Q.3.}}{\text{Q. takes B.}}$ 14. Q. to B.3. would have been better. Should Black venture on 11. Q. takes B., White ought to win, as the following variation shows:— 11. $\frac{\text{P. takes P.}}{\text{Q. takes B.}}$ 12. $\frac{\text{P. takes B.}}{\text{Kt. to K.2.}}$ (to avoid the mate, and at the same time prevent B. takes Kt. (ch.), followed by Q. takes P. and Q. to Q.B.3.) 13. $\frac{\text{Q. to B.7. (ch.)}}{\text{K. to Q.sq.}}$ 14. $\frac{\text{Kt. to K.2}}{\text{Q. takes R.}}$ 15. $\frac{\text{Castles}}{\text{R. to K.sq.}}$; *best* to avoid the mate by Q. to Q.B.3.(ch.) 16. $\frac{\text{Q.Kt. to B.3.}}{\text{Q. to Kt.7.}}$ 17. Q. takes P. White now threatens to win by R. to B.8. If, to prevent this, Black plays 17. Q. to B.7., with the object of bringing her to K.Kt.3., then White plays 18. P. to K.4. first. The only move for Black would be 18. Kt. to Q.5.; then follows 19. $\frac{\text{R. to B.8.}}{\text{Kt. takes Kt.(ch.)}}$ 20. $\frac{\text{B. takes Kt.}}{\text{P. to B.3.}}$ to avoid the mate by R. takes R.(ch). 21. $\frac{\text{R. takes R.(ch.)}}{\text{K. to B.2.}}$ 22. $\frac{\text{R. takes Kt.(ch.)}}{\text{B. takes R.}}$ 23. $\frac{\text{Q. takes B.(ch.)}}{\text{K. to Kt.3.}}$ 24. $\frac{\text{Kt. to R.4.(ch.)}}{\text{K. to R.4.}}$ 25. Q. to B.5.(ch.) and wins. We give a diagram of the position.

Position after Black's tenth move, Q. to B.7.

BLACK.



WHITE.

(f) Played to make the Rook available for attack. White could not now play 12. P. takes P., as pointed out by Mr. Bowley, as Black would win by 12. $\frac{\text{Q. to Kt.2.}}{\text{R. to K.B.sq.}}$ 13. $\frac{\text{Q. to Kt.2.}}{\text{B. takes P.}}$ winning, as Queen cannot take the Bishop on pain of Mate in two by Q. to B.8(.ch.) and Q. to K.B.8 Mate.

(g) White's game is now seriously compromised. If he had tried to play 16. Kt. to B.4., instead of P. to B.5., then Mr. Bowley points out that he would have played the fine move of R. takes Kt., and after the subsequent exchanges Black would retain a slight superiority, *e.g.*, $\frac{\text{Kt. to B.4.}}{\text{R. takes Kt.}}$ $\frac{\text{K.P. takes R.}}{\text{Q. takes Q.}}$ $\frac{\text{K. takes Q.}}{\text{Kt. to K.6.(ch.)}}$ &c. Of course White could not play Q. takes Q. in reply to R. takes Kt., for then Black would win by R. takes R.(ch.) and Kt. to K.6.(ch.)

(h) If Black play Kt. takes K.P., White's reply would be 19. $\frac{\text{R. takes R.}}{\text{Kt. takes Q.}}$ 20. $\frac{\text{Kt. to R.3.}}{}$ forcing the Queen back, and retaining three pieces for the Queen.

(i) A slip, of course. Mr. Bowley tells us that Kt. to B.4., giving back the piece would have been White's best; but even then Black would retain a superiority.

(j) White must lose the Queen, or be Mated in very few moves.

In last week's Chess column position numbered 3 should have been 4. In the solution to Mr. Healey's Problem 2 it is unnecessary to consider the reply, 1. K. to Q.R.sq., for if Black so play White can win by 2. R. to Q.B.7.

In reply to numerous correspondents, we note that solutions of all problems we may give will appear a fortnight later. Names of any who, having correctly solved problems, care to forward their results will also appear.

While adhering to our plan of giving fully annotated games, and analysis of the openings, we shall be glad to publish problems and games, &c., of interest, which correspondents may send us.

Our friend "The Enemy" (need we say we refer to Mephisto) sends us a three-mover, recently published in the *Glasgow Herald*, by Mr. C. R. Baxter, Dundee, which we shall venture to publish next week. In this problem our two-mover of last week would seem to be embodied. Sometimes such coincidences are accidental (we may give a case in point presently). As our two-mover was published in the *Illustrated London News* more than twenty years ago (more exactly, on May 7, 1859), we presume Mr. Baxter will hardly claim priority.

SYNCHRONISED ELECTRIC CLOCKS.—It appears that an error has occurred in the *Times*, and most of the papers, including KNOWLEDGE, in noticing the lecture lately given by Mr. John Lund, on the above subject at the Society of Telegraph Engineers. In mentioning the practicability of utilising the telegraph wires for the double purpose of telephoning and synchronising, it was stated that communication was effected between the Lecture-room and Messrs. Barraud & Lund's premises in Pall Mall, whereas it should have read, between the Lecture-room and the premises of Messrs. Lund & Blockley, in Pall Mall, who are concessionaires for the West-end district. The two firms are, however, otherwise distinct.

XUM

Answers to Correspondents.

**** All communications for the Editor requiring early attention should reach the Office on or before the Saturday preceding the current issue of* Knowledge, *the increasing circulation of which compels us to go to press early in the week.*

Hints to Correspondents.—1. *No questions asking for scientific information can be answered through the post.* 2. *Letters sent to the Editor for correspondents cannot be forwarded; nor can the names or addresses of correspondents be given in answer to private inquiries.* 3. *No queries or replies savouring of the nature of advertisements can be inserted.* 4. *Letters, queries, and replies are inserted, unless contrary to Rule* 3, *free of charge.* 5. *Correspondents should write on one side only of the paper, and put drawings on a separate leaf.* 6. *Each letter, query, or reply should have a title, and in replying to letters or queries, reference should be made to the number of letter or query, the page on which it appears, and its title.*

E. H. R. The Witch of Agnesi is one of those curves invented in former times for the solution of geometrical problems which cannot be solved by use of the circle and straight line only. We find little about it in our books. Its equation is given in Brande's "Dictionary of Art and Sciences." We must study it a little ourselves before answering your question; and, next week, hope to give a drawing of the curve and a brief account of it: geometrical, if possible.—Puzzled. We do not wonder you are puzzled. The statement in the *Times* is out of date where it is correct, and the rest of it amusingly inexact. Newspaper science is apt to be "mixed" in this way.—O. G. Wakefield. Your form of solution was specially excluded when the prize was offered. We have, however, given your solution as a good illustration of the way of writing down to any required position, altering, however, your notation, which occupies too much space.—W. W. Willmott. Your query appears, and number containing it has been sent to author of the paragraph.—E. C. R. Thanks for interesting letter.—W. A. S. Very glad indeed to hear from you. How long it is since we met. Your reply is a specially welcome one, for I feared that particular query would remain unanswered. Sought everywhere for information, but knowing no Rabbis could get none that was trustworthy.—Walter E. R. We hope to have many papers on Biological subjects ere long; but Science is infinite, and Knowledge is not.—John Bland. In your long letter you urge the familiar objections to the sun's being the source of heat, and advance a new theory of the tides. Of the former our readers have had a fair supply already, and the latter is quite inconsistent with known facts. You are also evidently unacquainted with the facts on which the accepted theories are based. For instance, you say the sun exercises greater attractive power than the moon, yet raises no double tide, the facts being (1) that the sun's tide-raising power is less than the moon's in the proportion of 2 to 5, yet (2) that he does raise a double tide of proportionate height. We wish you and others who propound paradoxes, to understand that your objections are in reality your difficulties. Those objections were difficulties to science students some two or three centuries ago. There is an unscientific objection to your communication on the ground of postage underpaid.—J. McGrigor Allan. We agree with much that you have written, but our pages are scarcely suited for the physiological study of the subject. We agreed to a concise presentation of your views, but supposed the column in Number 4 was what you meant; or, that if section 2 were treated at all, it would be very briefly. The other sections will be more suitable. Pray understand that we are satisfied no student of science could by any possibility object to your views or your way of putting them; but we write not for students of science only — *virginibus puerisque cantamus.*—Bertrand E. Dawson. There is no real difficulty. Binders have repeatedly to insert half-sheets. They will have to do so in the case of our star maps. There is much less risk of the single page separating from its fellows than of a full sheet coming out through imperfect sewing.—J. F. D. Selbst. It is impossible to insert your "intentionally ambiguous" remarks on the cause of gravity. Your replies to "Queries" 13 and 3 are unsatisfactory from a similar ambiguity. Your fears seem uncalled for. Publishing a new and sound theory on any subject whatever, by no means involves, as a necessary consequence, "starvation, despair, and early death." Wasting many years over a false theory, through unwise caution, may be more likely to lead to such undesirable results.—J. Hines. Your communication is too long for the subject, now nearly exhausted (though the sun's heat is not). The "prevailing hypothesis of the action of undulatory forces" is by no means inconsistent with the heat of the sun being "true heat in the naked form," that is (as we understand you) such heat as there is in a fire or furnace. Your theory is quite inconsistent with facts; and the growing pressure on our space, though it does not forbid our weighing objections and considering doubts, will not allow of our devoting columns to the careful enunciation of untenable hypotheses. No paradox-monger who can honestly say (and effectively show) that he has thoroughly mastered the accepted theories and the researches on which they rest, shall be refused ample space here. But paradoxes evidently based on misconceptions like those of Mr. Newton Crosland and others can no longer have the space which we earlier allowed them. They must make way for the sounder matter which reaches us.—H. M. Haassen. You can scarcely form an idea of the pressure on our space. Such a list as you suggest would be useful only to a small section of our readers. Almost every one who attends such meetings knows when they are to be held without our assistance.—John Spiller. Thanks for your letter, which shall appear, unabridged. It is very much to the purpose.—Actinolite. Have inserted the gist of your query, but have omitted the closing words. What has Knowledge to do with Professor Rawlinson's belief, or want of belief, in Mosaic chronology? We know nothing about the matter, to begin with; and we do not want to know.—Albert E. Holden. Thanks for your useful letter.—E. Kaych. Thanks for your suggestions. We are proceeding tentatively at present, and, indeed, just now our unexpectedly rapid success involves certain practical difficulties which will presently disappear. The principles which will guide us in the choice of subjects will be Darwinian,—to wit, natural selection and the survival of the fittest.—John Phillips. We consider art questions altogether suited to our columns; and shall be glad to admit correspondence on such subjects as you mention.—S. P. Eastick. We have been promised a paper on Faure's Accumulator by a skilful electrician; but there has been great delay. If your suggested contribution were short and simple, we should be glad to use it. Spare not illustrations such as the subject may require.—Dixon Kemp. Many thanks. We should be glad to hear of the results of your experiments.—Newton Crosland. Can insert only portions of your very voluminous letters. You misunderstand our comments; but not more than you have misunderstood the teachings of science.—Henry Siggin. We by no means intend to forget geology.—E. F. B. Harston. Thanks for kind wishes. Qnery appears.—A. Feood. Many thanks for your offer, but original matter, correspondence, queries, &c., leave no room for reports of lectures, which are nearly always unsatisfactory.—T. J. H. Your remarks on "Anti-Guebre's" letter are sufficiently sound, but he has been already answered. Wonderful to relate, he sees and admits his error. We say wonderful, because when anyone has allowed misapprehension to blossom into false theories, his case is too often past cure. There are the makings of a man of science in "Anti-Guebre."—S. S. S. S. We think it better to let our readers join in answering questions even on those subjects which we have specially studied. Where no other answer comes we shall endeavour to supply the omission, and, sometimes, as you may have noticed, we take the initiative. But we wish this to be a magazine of general knowledge, not a mere organ for the expression of Mr. Richard A. Proctor's opinions on things in general. *We* have, indeed, a number of questions to ask, only hitherto we have not been able to find room. Your query about spiritualism is omitted. We could not find space for the evidence which would pour in from all sides, for and against, still less could we find time to sift it, and without sifting, it would be of little worth either way. Another question is omitted as not quite suited to our pages. We must not offend even the weakest brethren, still less the weaker sisters.—E. C. R. Your letter about parhelia in 1879, is very interesting, but crowded out by more recent matter.—R. E. Winter. Note answer to Mr. McGrigor Allan.—B. M., F.R.A.S. Many thanks. Your interesting stories of intelligence in animals shall certainly appear.—J. Parker Fowler. In the great pressure of more strictly scientific matter, your hypothesis that ghosts and spectres, *et hoc genus omne*, may, perchance, be ultra violet or ultra red, and so only visible to certain eyes, cannot appear in our columns. We perceive that you do not regard it as "true, or even in any slight degree probable." We agree with you thoroughly, and also in considering that it is original. "If it has ever been started before," we, like yourself, "have never seen anything of it."—Harrie Russell. You will see that many stars are named in the maps for this month. We may shortly find space for the notes you suggest; but being astronomical ourselves, we do not wish to give our readers too much astronomy.—F. H. G. We hope to be able soon to give short biographies of eminent men of science. Space is our trouble just now. As we grow we shall do all we can.—F. Cowley. Many thanks.—R. C. Cowell. No advertisements need be bound in; of course there will be a title-page.—P. M. Turnbull. Compare the date of the passage you quote with that of Huxley's later utterances about automatism in animals.—Enquirer. Where do you get the "hydrogen of the air" in sufficient quantity to account for the heavy rainfall?—C. T. B. The question of the inferiority of woman has been now sufficiently discussed. Mathematical answer well known; chemical answer inserted.—R. J. Burnside, W. Mont, and others. Thanks.—Mary B. Alder. See reply above to C. T. B. Thanks.—J. D. Hardy. We regret that space cannot be found for your ingenious speculations about comets. Most probably the coma may consist of crystalline particles ("of the particular nature belonging to the gas" forming the comet as a whole); but the laws of optics will not permit us to regard the tail as produced in the way you suggest. Moreover, the motion of the particles under solar attraction would not be what you suppose. Each particle would travel on its proper ellipse as certainly as a planet would. We, unfortunately, *must* limit greatly the space we allow to the unsound, however ingenious, in order that we may keep room for scientific truths.—A. S. Farquharson. We would rather not insert your query. Sleep preventatives are not rashly to be meddled with. Better yield to nature's hints that she needs her "sweet restorer."—Amicus. Your mathematical problem belongs to an easy class; we have left it for our mathematical readers to deal with.—D. C. Anderson. Your kind suggestion noted.—W. H. Pertwee. Have printed the passage you have kindly sent me; recognised an old friend in it, as you will see.—Vega. Thanks; an obvious mistake.—E. M. King. The article was not such easy reading as we could have wished; but the author is very eminent in that department.—J. A. L. R. Your reasoning, which is perfectly sound, has already been employed (p. 8).—Weather Guide. A correspondent suggests that a weather guide might be framed "without difficulty," in which the indications of the heavens, stars, moon, sun, clouds, movements and cries of animals and birds, the human body, plants, flowers, liquids, apparent nearness or distance of hills, &c., would help. We believe such a guide might be framed, but not without difficulty. "Exceptions" would, probably, occupy the larger part of the guide. But the matter is worth considering.

We are sorry to say that we continue to receive many letters calling attention to the difficulty of obtaining copies of Knowledge. We can only repeat that we have done all in our power to prevent this, and that our publishers will be obliged if subscribers will call their attention to the fact, should they experience any difficulty in obtaining Knowledge at any of the railway book-stalls, or from their local newsagents. To ensure a supply of the Back Numbers, which are rapidly becoming scarce, orders should be sent without delay.—Ed.

Knowledge.—Although we offer our readers more in the way of original matter (apart from correspondence, which is not to be estimated by mere bulk) than any other journal of similar price and character, we wish to do better still. We hope so to extend the circulation of Knowledge that we may be justified in enlarging each number, in giving more illustrations, and in extending the number of our original contributors. *To attain this end we need the co-operation of our readers.* Those among them who approve our scope and plan can do more to improve Knowledge than either editor or publishers. If every reader were to obtain but one new subscriber, not only would our circulation be doubled, but our power to improve the matter placed before our readers would be increased in like proportion. If our readers will remember this, they will follow the best course for making Knowledge what we wish and hope that it may before long become.

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